FINAL DRAFT

STORMWATER PROGRAM

Eight Basin Deficiency Study

B&V PROJECT NO. 197573

PREPARED FOR

Unified Government of Wyandotte County and Kansas City, Kansas

4 MARCH 2020

BLACK & VEATCH

Table of Contents

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Acknowledgements

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Introduction

The Unified Government (UG) of Wyandotte County and Kansas City, Kansas directs a Stormwater Program to address flooding, water quality, and to provide maintenance in a 160-square mile service area that extends across 50 watersheds, shown in Figure 1. In 2017, the UG Public Works team identified a need to become more proactive in stormwater management. As a preliminary step, the team engaged Black & Veatch to characterize existing stormwater infrastructure data and identify known problem areas. In 2018, the study team identified 87 individual sites with drainage issues across the service area. These issues were characterized based on anecdotal accounts and Lucity work order data. Over half of these known problem areas were located in eight watersheds. The UG defined these eight watersheds, highlighted in Figure 1, to be the primary focus for a Deficiency Study.

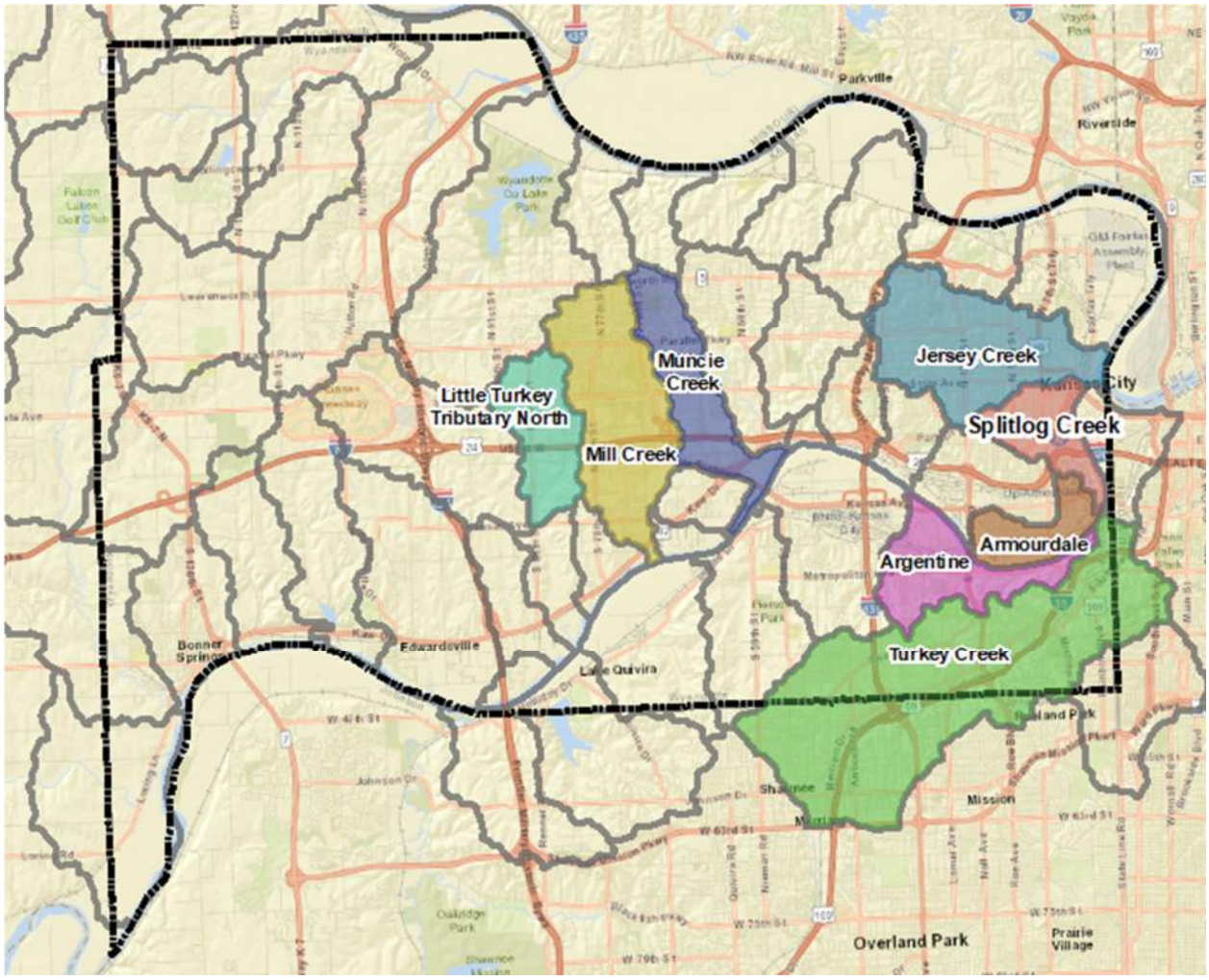

Figure 1. Wyandotte County Watersheds

Black & Veatch was engaged by UG to complete a Deficiency Study, focused on these eight watersheds. This culminating s report presents a brief overview of the Stormwater Program followed by the Deficiency

Study process and outcomes. The Deficiency Study included three main components: 1) assessment of existing data, 2) a preliminary site prioritization, and 3) concept design for recommended improvements to address flooding at 12 priority sites. This report presents recommendations and an opinion of probable construction cost along with a prioritization for each of the 12 sites, presented in Figure 2. B&V worked closely with the UG on prioritization of each of these sites.

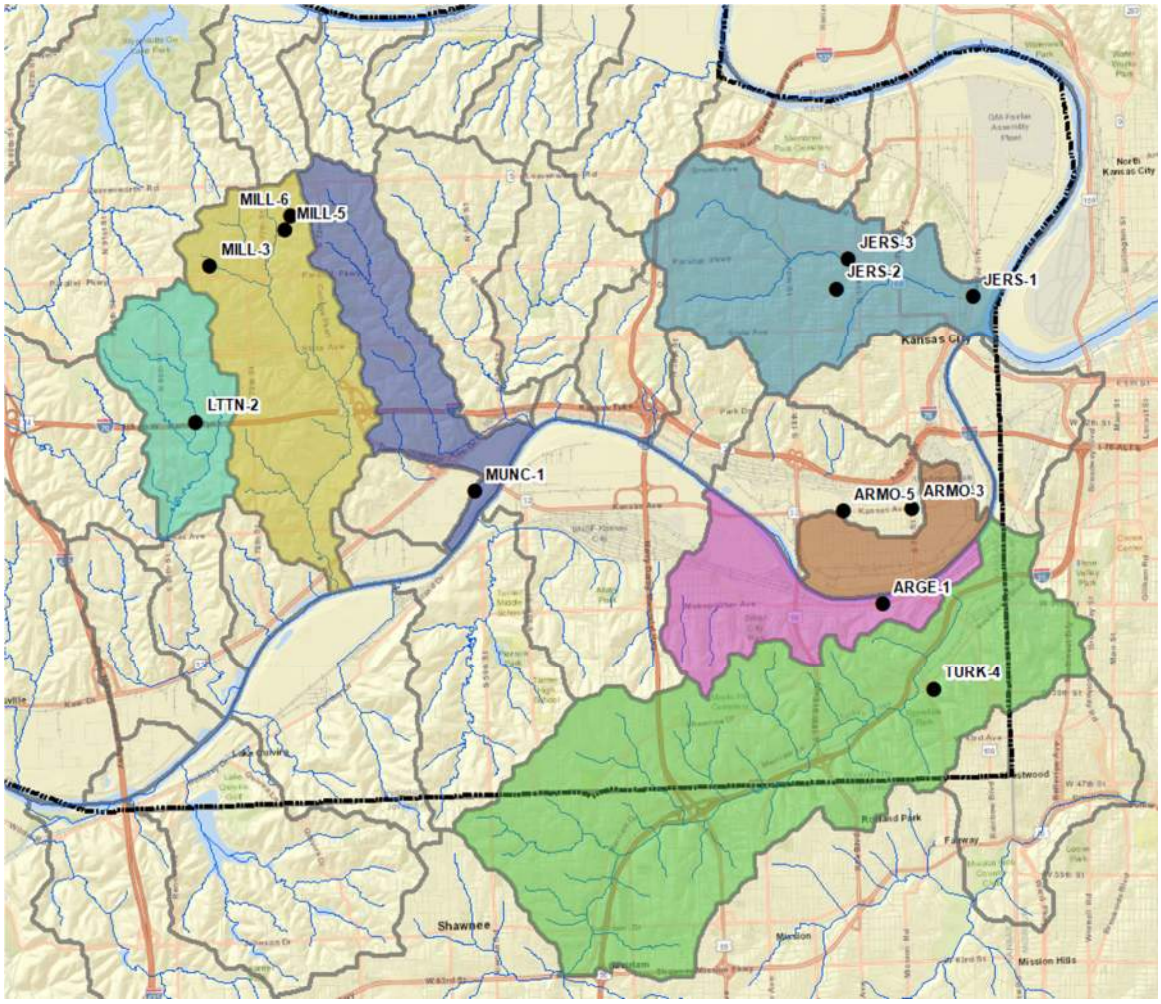

Figure 2. Recommended Project Locations

DEFICIENCY STUDY TIMELINE AND PROCESS

This study was initiated in in November of 2017 with a workshop to establish the program vision. Various workshops were conducted to understand existing and known problems across the service area, identify data gaps, review conceptual designs, and to create a framework for strategic asset management of existing and proposed stormwater infrastructure. Key meeting minutes documenting attendees and discussion are provided in Appendix A. A summary of the workshops follows:

Visioning Workshop

Shockey Consulting facilitated a summit with the Unified Government staff and the project team of Black & Veatch and Shockey Consulting Services on Thursday November 30, 2017. The purpose of the meeting was to develop a 10-year vision and mission statement for the stormwater program, develop 5-year goal statements, and develop a framework for program elements including prioritization.

Known Problem Identification Workshops

Known Problems Identification Workshops were held on February 7 and February 21, 2018. The purpose of these meetings was to review the known problem areas identified by UG staff, with a focus on flooding, water quality impairment, and failing infrastructure. During this workshop, the team identified key watersheds for the Deficiency Study.

Phase I Workshop

The Phase 1 report included the program vision, identification of gaps, known problems, and a review of standards and ordinances. The Phase I Workshop was held of April 16, 2018, to review the Phase I draft report, define assumptions moving into Phase II and identify overlapping projects that may be prioritized in the Deficiency Study.

Strategic Asset Management Planning Workshops

The project team held four workshops to develop the Strategic Asset Management Planning (SAMP). Workshops were held on the following dates: June 19, June 26, July 16, August 16, 2018. The purpose of these workshops was to establish a foundation for developing an asset management planning framework. The following tasks were completed:

- Reviewed effective asset management programs
- Established goals and objectives for the UG program
- Defined asset types
- Identified regulatory requirements and service level commitments
- Reviewed risk prioritization approach for assets
- Identified information systems to support management.

Concept Design Workshop

The Concept Design workshop provided an overview of key sites that were selected for an initial CIP. Several conceptual solutions were discussed with the UG and the design team received feedback on concepts and design criteria.

CIP and Policy Workshop

The CIP and Policy Workshop was held on October 8, 2018 at the UG City Hall. The purpose of the CIP workshop was to discuss the methodology and priorities for the projects identified in the Deficiency Study, present the proposed project locations and preliminary budget. Opportunities for coordination with other projects or entities was also discussed. The second portion of the workshop focused on the strengths and concerns with the existing UG policies, ordinances, design criteria, and overall program.

SUMMARY OF STORMWATER POLICIES

The Unified Government (UG) must meet many legislative requirements including Federal, State of Kansas, and UG Code of Ordinances regulations with regards to management and enforcement of stormwater infrastructure and conveyance. The recommendations in this Deficiency Study were developed with consideration to the regulatory requirements presented in Table 1.

Table 1. Existing Regulatory Requirements

LEGISLATION	SUMMARY OF REQUIREMENT
40 CFR – Clean Water Act	Establishes the basic structure for regulating pollutant discharges into the waters of the United States and gives the Environmental Protection Agency (EPA) the authority to implement pollution control programs.
EPA Long Term Control Plan for Combined Sewers	Establishes requirements to address sewer overflows and develop overflow control plan, implement improved Stormwater Management Plan and reduce pollution levels in urban stormwater.
National Pollutant Discharge Elimination System (NPDES) Permit – KS0095656	Establishes pollutant limits on what the UG can discharge into waters of the U.S., monitoring and reporting requirements, and other provisions to ensure discharge is not a danger to water quality or public health.
Kansas Water Pollution Control MS4 M-MO25-SO01	A type of NPDES permit that establishes requirements for the UG to determine and implement best management practices (BMPs) to reduce the quantity of pollutants entering into and/or discharging from the Municipal Separate Storm Sewer System (MS4).
Chapter 8, Article XIV, Sec. 8-611 (UG Code of Ordinances)	Establishes requirements to protect and enhance the water quality of watercourses, water bodies, and wetlands by controlling erosion, sedimentation, and related environmental damage caused by construction-related or other activities in compliance with NPDES permit.
Chapter 8, Article XV (UG Code of Ordinances)	Establishes minimum requirements for post-construction stormwater treatment on any new development or redevelopment of land. Also establishes reporting requirements on any owner of any private stormwater treatment facility.
Chapter 27, Article VI, Sec. 27-212 (UG Code of Ordinances)	Establishes requirement for inclusion of stormwater control in final engineering plans portion of overall development plan.
Chapter 27, Article VI, Sec. 27-215 (UG Code of Ordinances)	Establishes submittal requirements for subdivision preliminary plats which must include items such as approximate gradients for proposed stormwater facilities and preliminary stormwater calculations and best management practice/detention basin requirements.
Chapter 27, Article VI, Sec. 27-315 (UG Code of Ordinances)	Establishes requirements for construction of culverts, storm sewers, rip-rap slopes, stabilized ditches and other improvements to adequately handle stormwater as part of subdivision construction activities.
Chapter 30, Article VIII (UG Code of Ordinances)	Establishes a Unified Government stormwater and surface water utility and stormwater and surface water management system for the operation,

LEGISLATION	SUMMARY OF REQUIREMENT
	regulation, construction, maintenance and repair of a stormwater and surface water management system and stormwater and surface water utility.
Chapter 32, Article II, Sec. 32-27 (UG Code of Ordinances)	Establishes requirements preventing the construction, maintenance, or creation of any fixed structure, material or object which prevents the unobstructed flow of stormwater along the gutter of any street and the option for the UG to require removal.

Stormwater Program Overview

The UG service area extends across 50 watersheds that present a wide range of land use and characteristics. About 16 percent of the area is served by combined sewer systems where stormwater mixes with wastewater and is sent to a nearby treatment plant. The remaining 84 percent of the County is served by a separate stormwater system or open channel system, and drainage is conveyed with open channels and structures at road crossings. The existing program has traditionally had two main areas of focus: 1) addressing flooding challenges to ensure resident safety and 2) water quality to comply with National Pollutant Discharge Elimination System (NPDES) Phase 1 permits. This deficiency study focused on these two areas, however, the future program is anticipated to expand to include additional areas of focus.

Flood Mitigation

The service area includes a complex system of storm drains, pipes, culverts, drainage ditches, and natural waterways that convey stormwater drainage away from structures and roadways. Additionally, the UG is protected by a flood control system including 20 miles of flood control levees and 15 pump stations. The UG operates 9 of these flood pump stations. To ensure that stormwater systems have sufficient capacity and to reduce the risk of flooding, the UG has adopted storm drainage design criteria.

Regulatory Compliance

The UG has formalized a Stormwater Management Plan to address water quality and comply with regulatory Municipal Separate Storm Sewer System (MS4) requirements. The focus of this plan is to reduce the discharge of pollutants to area streams, protecting water quality and ensuring compliance with the Clean Water Act. This plan provides minimum controls and performance measures. In 2017, the UG established three supporting ordinances: Illicit Discharge, Construction Sites, and Post Construction. Additionally, the UG has established a Stormwater Quality Education Grant Program to help fund educational projects and activities related to stormwater quality. The Grant Program is funded by the UG's Stormwater Utility Fund and is administered by the Public Works Department.

In addition to the Stormwater Management Plan, the UG has developed an Integrated Overflow Control Plan to reduce combined sewer overflows and improve the waterways. This plan addresses the investigation and repair of sewer infrastructure, construction of a new wastewater treatment plant, integration of green infrastructure, and increased maintenance for facilities.

Desired Future State

A primary goal for UG Public Works is to shift the Stormwater Program from reactionary, where the work is driven by flooding complaints, to proactive, where stormwater investments can be used to catalyze community benefits. A proactive program can leverage a prioritized list of projects and a comprehensive understanding of the system to make informed funding decisions. In 10 years, stormwater improvements should be selected using a risk assessment process that is informed by both likelihood and consequence of flooding, and for the work to be funded through dedicated sources. For water quality, the desired result for the Stormwater Program is to focus efforts where significant impact can be made on waterbodies that people use and that are important to the UG community. The team may prioritize highly visible projects that achieve multiple community benefits focusing efforts on water quality hot spots throughout the entire system. Additionally, the UG will continue to ensure that regulations and evolving regulatory requirements are met.

This Deficiency Study and the supporting workshops provide an initial roadmap to help the UG transition to a proactive program. This study describes known problems and the associated available data across eight basins. Initial funding needs are defined by the conceptual projects that were developed for highest priority sites in these basins.

Data Gap Analysis

Historical stormwater reports and existing data were reviewed during an initial study phase. This information set included 20 reports, work order data, asset information in GIS, a HEC-RAS model for Turkey Creek, FEMA floodplain information, available model information used to develop the FEMA floodplains, and a HEC-RAS model for the Missouri and Kansas Rivers developed by the United States Corps of Engineers (USACE). Additionally, the UG Integrated Overflow Control Program data was evaluated in combined sewer system areas.

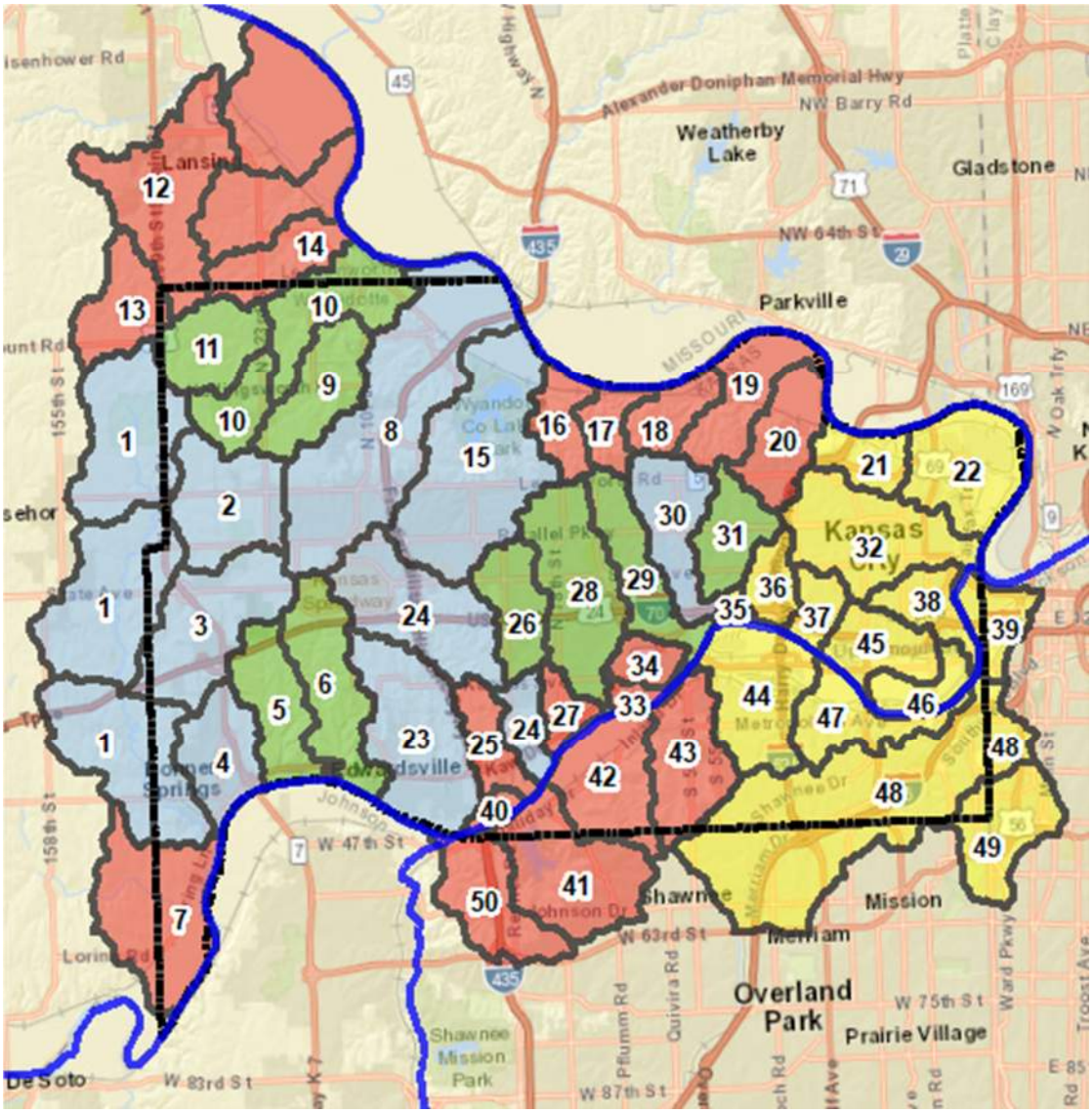

Figure 3. Watershed Data in Wyandotte County

Figure 3 presents watersheds, or basins, with combined sewer systems included in the IOCP (yellow), recent modeling for the FEMA FIS (blue), limited/old hardcopy information for the FEMA FIS (green), and watersheds without known information (red). A corresponding list of the numbered watersheds is provided in Appendix B. A detailed list of watersheds and known studies is provided in Appendix C.

There are key areas where information is missing or underdeveloped. Three major gaps were identified in this review:

- Survey of Existing Assets that characterizes the network, pipe sizes and inverts
- Hydrologic & Hydraulic modeling of areas of concern, specific to flood events
- Comprehensive assessment of existing conditions

Known Problem Identification

A "Known Problem Identification Workshop" was held on 7 February 2018. In this meeting, B&V summarized the data collection effort and the resulting areas of highest concern. The team identified a total of 87 individual sites with drainage issues, based on anecdotal accounts and Lucity work order data. Over half of these known problem areas were in eight watersheds. The UG confirmed that the following eight basins should be the primary focus for this Deficiency Study:

- Turkey Creek, 1,512 work orders
- Jersey Creek, 1,158 work orders
- Mill Creek, 976 work orders
- Muncie Creek, 233 work orders
- Splitlog Creek, 218 work orders
- Argentine, 172 work orders
- Little Turkey Tributary North, 95 work orders
- Armourdale

A total of 46 problem locations in these basins were further evaluated to understand available data, potential for connectivity, and relative priority. Table 1 presents a summary of these sites and detailed descriptions of each site are provided in Appendix D. In the Splitlog Creek basin, work orders were related to maintenance issues, and not the performance of the system.

A preliminary prioritization scheme was developed to identify the highest priority projects in the eight basins. Projects were assigned a category based on the following:

- **Multiple Benefit Projects** may be highly visible, urgent, leverage other funding sources, and/or overlay other community plans.
- **High Priority Projects** include roadway flooding and potential associated building flooding and/or significant associated work orders in Lucity.
- **Priority Projects** are anecdotal, located upstream in the watershed.

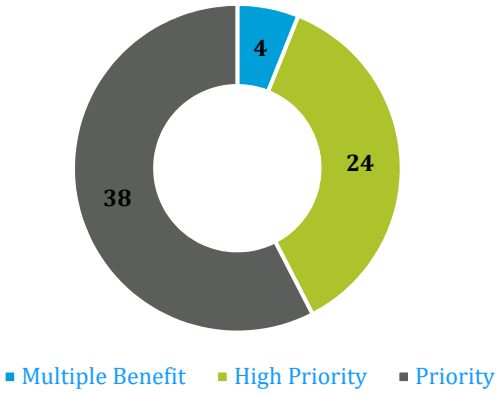

Figure 4. Known Problem Ratings in Study Area

Figure 4 presents the distribution of priority for sites in the eight basins. The team facilitated a Concept Design Workshop on June 26, 2018 and recommended 10 sites to advance to a conceptual design. The UG requested 2 additional sites for development of conceptual design recommendations. A subsequent workshop on October 8, 2018 further refined the project list. These sites, presented in Table 2, were selected based on the preliminary prioritization category, downstream location in the watershed, and to ensure positive impact across the service area.

Table 2. Recommended Project Descriptions and Preliminary Ratings

Project ID	Location Description	Preliminary Rating
ARGE-1	Site is directly adjacent to the Kansas River and is bordered by S 7th Street Trafficway to the east and S 12th Street to the west.	High Priority
ARMO-3	Site is in the Armourdale neighborhood, adjacent to the Kansas River. The project area includes the intersection of 7th Street Trafficway and Kansas Avenue, as well as Scott Avenue.	High Priority
ARMO-5	Site is located in the Armourdale neighborhood, adjacent to the Kansas River. The site extends along S 12th Street and is bounded on the north by McAlpine Avenue, two blocks north of Kansas Avenue.	Multiple Benefit
JERS-1	Site is located at the downstream portion of the Jersey Creek watershed, adjacent to the Missouri River.	High Priority

Project ID	Location Description	Preliminary Rating
JERS-2	Roadway flooding has been documented between 9th Street and Armstrong Avenue, including the intersection of 19th Street and Minnesota Avenue, Washington Boulevard and 13th Street, and Washington Boulevard and 15th Street.	Multiple Benefit
JERS-3	This site includes a reach of Jersey Creek located in Jersey Creek Park, extending nearly 4,000 linear feet south of Parallel Parkway, bounded by North 18th Street on the west and North 10th Street on the east.	High Priority
LTTN-2	Site is located directly north of I-70 near the source of the Little Turkey Tributary. This tributary is located east of N 86th Street and flows under I-70 toward the Kansas River.	Multiple Benefit
MILL-3	Site is located north and south of Parallel Parkway. Stormwater drains east to Mill Creek located directly south of intersection Greeley Avenue and N 81st Street.	High Priority
MILL-5	The site is located along Georgia Avenue, bounded on the west by N 75th Terrace and on the east by North 73rd Street.	High Priority
MILL-6	Site is located along Yecker Avenue and is bordered by N 74th Street and N 73rd Street.	High Priority
MUNC-1	Site is located south of the Kaw Valley Scenic Highway and west of the Kansas River.	High Priority
TURK-4	Site is located near the ramps off of Southwest Boulevard onto Mission Road/Interstate I-35.	Multiple Benefit

Concept Design

For each of the twelve recommended projects, the concept design process included field survey to address data gaps, hydrologic and hydraulic modeling, and development of recommended projects to meet UG's stormwater design criteria. A detailed prioritization and opinion of probable construction cost was established for each recommended project.

FIELD SURVEY

A limited field survey was completed to fill data gaps associated with the stormwater drainage system at each project site. Information collected was associated with the Facility ID to allow for efficient integration into the UG GIS database. The survey established accurate locations, sizes and inverts of existing stormwater infrastructure, including the following infrastructure:

- Catch basins – Defined by UG GIS structure identifier, inlet opening dimensions, inlet invert elevation, top of structure, and inverts of structure
- Stormwater pipes or culverts – Defined by UG GIS structure identifier, upstream and downstream invert elevations, shape, and dimensions
- Outfalls – Defined by UG GIS structure identifier, invert elevations, shape, dimension, and an indication of whether a flap gate is present
- Discovered objects – Same data needs as objects above, but with a temporary structure ID and positional data like northing and easting. Sewers or culverts would need either an upstream and downstream point or the upstream and downstream structure identifiers.

HYDROLOGIC AND HYDRAULIC MODELING

The XP-SWMM platform was used to develop an updated and consistent model of each project site, integrating the updated field survey data. Drainage areas were delineated to each site and associated with representative curve number and time of concentration.

These updated hydrologic and hydraulic models were used to characterize the extent of flooding associated with each project site. Proposed solutions were developed based on design criteria summarized in the following section. These solutions were validated in the SWMM models.

DESIGN CRITERIA

Each concept was designed to satisfy the UG's stormwater design criteria, based on conveying the 5-year storm event below ground. An SCS Type II Distribution and existing land use data was used. Additionally, based on feedback during the Concept Design workshop, HDPE was assumed in place of RCP when placing new pipe through residential parcels. At the next phase of design, sites should be further evaluated to ensure allowable conditions for a 100-year storm event:

- No building flooding is allowed for the 100-year event,
- No overflow of arterial and collector streets is allowed for the 100-year event, and
- Some overflow from the 100-year event is allowed for local streets.

RECOMMENDED PROJECTS

Concept recommendations were developed for each of the 12 project sites. Figure 2 presents a site map for recommended projects. Table 3 summarizes the existing flooding concern and a summary of the recommended solution at these selected sites. Detailed maps and descriptions are provided in Appendix E.

Table 3. Recommended Project Summaries

Project ID	Existing Conditions	Recommended Project
ARGE-1	Drainage issues were documented primarily along Metropolitan Avenue. Reported issues also include a natural spring near 12th Street and Ruby Avenue which contributes to icy conditions during the winter. The UG noted that a pipe outfall in the vicinity of 10th Street and conveys a significant amount of flow, however, a pipe network upstream of the existing outfall was not documented in the field evaluation. Survey confirmed the lack of a combined sewer or stormwater sewer along Metropolitan Avenue.	To convey the 5-year, 24-hour storm event within this project area, additional pipe and inlet capacity is necessary
ARMO-3	Roadway flooding occurs along Scott Avenue from 5th Street to 7th Street and in the intersection of 7th Street Trafficway and Kansas Avenue. This flooding area coincides with a recommended project area in the Integrated Overflow Control Plan. The existing stormwater infrastructure network at ARMO-3 is not continuous along the 7th Street Trafficway.	To capture and convey the 5-year, 24-hour storm event below ground to alleviate street flooding in this area, the pipe and inlet capacity along 7th Street Trafficway, Scott Avenue, and Shawnee Avenue should be increased.
ARMO-5*	Flooding has been documented along 12th Street from McAlpine Avenue to the Kansas River. The intersections of 12th Street with Argentine Boulevard and Kansas Avenue are included within the extents. The existing system along 12th Street consists of an older brick sewer main that conveys combined sewer and stormwater flows. The drainage area for this project is approximately 613 acres.	To convey the 5-year, 24-hour storm event and alleviate flooding along South 12th Street, a new stormwater pipe and inlet capacity is required.
JERS-1	During the 5-year event, peak flows range from 4,100 cubic feet per second (cfs) in the upstream end to 6,400 cfs at the downstream end. At peak flow in Jersey Creek, the contributing stormwater drainage network surcharges. Although no specific flooding issues were documented for this area, the model shows localized flooding in the park and overland flow in the contributing system.	Based on discussion with the UG and review of area plans, the proposed solution includes restoring the concrete-lined channel to a stabilized natural channel. An initial concept was developed to establish a cost estimate for the proposed improvement. This concept is based on development of a stable natural channel, sized to convey the 2-year peak discharge, the channel forming flow. Flood benches were integrated to ensure that the 5-year peak discharge is contained within the channel.

Project ID	Existing Conditions	Recommended Project
JERS-2	Roadway flooding has been documented between 9th Street and Armstrong Avenue, including the intersection of 19th Street and Minnesota Avenue, Washington Boulevard and 13th Street, and Washington Boulevard and 15th Street. This site overlaps a recommended project area in the Integrated Overflow Control Plan, with the existing combined sewer system discharging to Jersey Creek and causing water quality issues. Conceptual modeling confirmed a lack of pipe conveyance and inlet capacity throughout the project area	To capture and convey the 5-year, 24-hour storm event below ground and to alleviate roadway flooding in the project area, new stormwater pipe and inlet capacity is required.
JERS-3	At peak flow in Jersey Creek, the contributing stormwater drainage network surcharges within the park. Although no specific flooding issues were documented for this area, the model shows localized flooding in the park and overland flow in the contributing system.	The proposed solution includes restoring the concrete-lined channel to a stabilized natural channel.
LTTN-2	Modeling confirmed reported flooding at the I-70 culvert during the 5-year, 24-hour event. Reports documented structural flooding along 83rd Terrace between Isabel Avenue and Ella Avenue. The area of flooding documented in the modeling showed impact to five properties, located south of Ella Avenue. A concrete channel conveys the bulk of the flow from the area to the south; surveyed conditions showed significant damage to the concrete lining,	The proposed solution for this site includes purchase of the parcels adjacent to the stream channel and development of a detention facility that provides approximately 2.9 acre-ft of storage. Additionally, the concrete-lined channel is proposed to be returned to an engineered natural channel to reduce cost of operation and maintenance.
MILL-3	Reports documented roadway and yard flooding along 82nd Terrace between Haskell Avenue and Greeley Avenue, and along Greeley Avenue between 82nd Terrace and 81st Street. The existing storm system and contributing watershed contains an inadequately sized and discontinuous storm sewer system resulting in street and yard flooding. The total drainage area is approximately 168 acres.	To convey the 5-year, 24-hour storm event within this project area, additional pipe and inlet capacity is necessary
MILL-5	Existing records document roadway and property flooding at 73rd Terrace and Georgia Avenue. The existing pipe under 73rd Place does not have sufficient capacity. Additionally, the UG noted the poor condition of the pipe that drains this subarea, passing under N 75th Terrace and conveying flow to Mill Creek. The total drainage area is approximately 126 acres.	To convey the 5-year, 24-hour storm event within this project area, additional pipe and inlet capacity is necessary
MILL-6	The MILL-6 site conveys stormwater from a small watershed of roughly 20 acres. The existing stormwater network is minimal and consists of corrugated metal pipe (CMP).	To convey the 5-year, 24-hour storm event within this project area, additional pipe and inlet capacity is necessary. Additional HDPE pipe is integrated to

Project ID	Existing Conditions	Recommended Project
	Flooding has been documented near N 74th Street and Yecker Avenue. At this intersection, two CMP culverts drain west towards Mill Creek.	provide drainage along Yecker Avenue. A naturalized channel could be considered as an alternate. Limited regrading is associated with the addition of any new pipe to ensure drainage.
MUNC-1	Drainage issues have been reported along Speaker Road, Royal Drive, and South 59th Lane. Survey of the site indicated that the downstream outfall of this section has been compromised.	To be able to convey the 5-year storm event, the proposed solution includes replacement of the outfall, structure 220-509-DP. Additionally, this section will need to be upsized to a maximum pipe diameter of 60-inch RCP. To address the drainage issues along Speaker Road, the proposed solution extends the stormwater network north for a total of 985 feet of 48" RCP. The stormwater swale can continue to convey runoff from Speaker Road provided that sediment deposits are removed and grading further evaluated.
TURK-4	Roadway flooding has been documented at the Southwest Boulevard and Mission Road interchange, extending south along Mission Road to 40th Terrace	In order to adequately convey the 5-year storm event to the existing TURK-4 outfall, the main conveyance line will need to be substantially upsized. Note to evaluate interceptor concept during preliminary engineering.

DETAILED PRIORITIZATION

A detailed prioritization scheme was developed based on refined data and modeling results for each site. This approach, presented in Table 4, was developed during the October 8, 2018 workshop to understand the relative priority between the recommended projects.

Table 4. Prioritization Scheme

CATEGORY	DESCRIPTION	WEIGHTED SCORE
Potential Loss of Human Life / Impact to Human Health	Structure Flooding	40
	Roadway Flooding (Arterial)	30
	Roadway Flooding (Minor Arterial)	20
	Roadway Flooding (Residential)	10
Economic Impact/ Property Damage	Structure Flooding	20
	Yard Flooding	10
Multiple Benefit Opportunities	Overlap with Roadway Improvement Plans	30
	Overlap with Integrated Overflow Control Plans	30
Environmental Impact	Project includes natural water feature or water quality feature	5
Alternate Funding	Project area may be eligible for cost share	5

At each project site, scores were developed to characterize the impact to human life, economy, and the environment. Points were also associated with the potential for a project to provide multiple benefits or to qualify for alternate funding. The resulting scores are presented in Table 5.

Table 5. Prioritization of Selected Projects

PRIORITY	RECOMMENDED IMPROVEMENT	INITIAL PRIORITY RATING	HUMAN LIFE IMPACT	ECONOMIC IMPACT	MULTIPLE BENEFIT	ENVIRONMENTAL IMPACT	ALTERNATE FUNDING POTENTIAL	TOTAL SCORE
1	JERS-2*	Multiple Benefit	30	0	30	0	0	60
2	LTTN-2	Multiple Benefit	40	20	0	0	0	60
3	ARMO-3	High Priority	20	0	30	0	0	50
4	ARMO-5*	Multiple Benefit	20	0	30	0	0	50
5	JERS-3	High Priority	0	0	30	5	0	35
6	TURK-4	Multiple Benefit	30	0	0	0	5	35
7	MUNC-1	High Priority	20	10	0	0	0	30
8	JERS-1	High Priority	20	0	0	0	5	25
9	ARGE-1	High Priority	20	0	0	0	0	20
10	MILL-3	High Priority	10	10	0	0	0	20
11	MILL-5	High Priority	10	10	0	0	0	20
12	MILL-6	High Priority	10	10	0	0	0	20

*Integrated Overflow Control Plan Project Site

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OPINION OF COST DEVELOPMENT

An opinion of probable cost was developed for each site and is presented in Table 6 in 2018 dollars. Detailed cost tables are provided in Appendix F.

Table 6. Summary of Probable Cost

RECOMMENDED IMPROVEMENT	PROBABLE COST (2018)
ARGE-1	$ 6,116,700
ARMO-3	$ 16,242,400
ARMO-5*	$ 36,345,300
JERS-1	$ 2,479,900
JERS-2*	$ 29,385,500
JERS-3	$ 32,629,900
LTTN-2	$ 1,164,600
MILL-3	$ 3,511,300
MILL-5	$ 1,338,100
MILL-6	$ 977,700
MUNC-1	$ 3,686,300
TURK-4	$ 3,606,300

*Integrated Overflow Control Plan Project Site

A conceptual opinion of probable cost differs from a detailed cost estimate in that many of the site-specific details of a project that are determined during design are unavailable at the time of preparing probable costs during the conceptual phase of a project such as this. Therefore, assumptions and contingencies are required to account for these uncertainties about site-specific conditions that have yet to be determined, with the objective of providing an initial cost that decreases as more is learned about the conditions at a particular location.

The Engineer's Opinion of Probable Construction Cost (OPCC) Estimate includes anticipated construction costs including escalation to midpoint of construction, construction contingency, permitting fees, applicable taxes. Budget costs were developed from Black & Veatch data base with the basis of historical cost from past projects, estimating team experience in the industry, NECA man hours for electrical labor, MCAA man hours for process mechanical labor, material cost from historical quotes as well as numerous other sources. Based on the aggregate of said data, the OPCC was developed. Several of the main assumptions used for developing the conceptual opinion of probable cost for each of the stormwater improvement projects discussed in this report are as follows:

- The possibly that bedrock will be encountered at any of the sites is not explicitly considered as part of the unit costs for installing stormwater facilities for an opinion of probable cost since this study did not review any geologic information.
- Unit costs for pipes include excavation and backfill. Assume all pipes have at least 3 feet of cover.
- Pavement removal and replacement is based on a rough estimate of the length of new pipe along paved area as determined by aerial photos and assumptions about the depth and width of the excavation needed to install each pipe.
- Reinforced concrete volume is based on estimates of concrete volume required at the outlet of the stormwater systems and at the inlets of culverts; excavation and backfill is included in these areas.
- As mentioned above, a stormwater hydraulic model analysis at the conceptual level includes a dynamic analysis of the effects of backwater, pressure flow, friction and minor losses, and system storage, but it does not include a detailed study of the exact placement and capacity of each street inlet which occurs during design when detailed topography becomes available. For developing an opinion of probable cost for this conceptual analysis, the peak flowrates determined by the hydrologic model are used as a guide to estimate the number of inlets that may be required.

Next Steps

A primary goal for the next five years is to shift the UG Stormwater Program from reactionary, where the work is driven by flooding complaints, to proactive. Investment in future planning will provide a roadmap, a comprehensive long-term Capital Improvement Plan that ensures consistent evaluation and prioritization of projects across the entire service area. Near term planning may develop guidance for the highest priority watersheds, characterizing the existing assets, capacity, and prioritizing solutions. This effort may also include the standardization of preliminary engineering plans, refinement of standards, stakeholder engagement to build support for the program. Asset management planning will characterize the UG's risk based on likelihood and consequence of flooding, identify performance measures and strategies to optimize maintenance. Overall, a proactive program will leverage a prioritized list of projects and a comprehensive understanding of the system to make informed funding decisions.

References

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Unified Government of Wyandotte County, Kansas City, Kansas, *Storm Drainage Design Criteria for Private Developments* http://www.wycokck.org/WycoKCK/media/Urban-Planning-Land-Use/Documents/Storm-Drainage-Criteria.pdf .

Unified Government of Wyandotte County, Kansas City, Kansas, *UG Infrastructure Database*, ArcMap GIS database. Revised October 2018.

US Department of Transportation, Federal Highway Administration, 2013, *Hydraulic Engineering Circular No. 22: Urban Drainage Design Manual*, Third Edition, FHWA-NHI-10-009, revised August 2013, original September 2009

APPENDIX A – MEETING MINUTES

The following meetings were held during the development of this study. Meeting minutes for select meetings are provided in this appendix. It should be noted that some of the minutes refer to a masterplan document. Due to the availability of data and funding, the course of this study culminated in a Deficiency Study focused on priority watersheds rather than a comprehensive masterplan.

MEETING TOPIC	DATE
Visioning Workshop	November 30, 2017
Known Problem Identification Workshop #1	February 7, 2018
Known Problem Identification Workshop #2	February 21, 2018
Phase 1 Workshop	April 16, 2018
Concept Design Workshop	June 19, 2018
Strategic Asset Management Plan Workshop #1	June 19, 2018
Strategic Asset Management Plan Workshop #2	June 26, 2018
Strategic Asset Management Plan Workshop #3	July 16, 2018
Strategic Asset Management Plan Workshop #4	August 16, 2018
Project and Policy Workshop	October 8, 2018
Stormwater Engagement Plan	November 14, 2018

VISIONING WORKSHOP SUMMARY

Unified Government of Wyandotte County and Kansas City, Kansas 197573
Stormwater Master Plan Phase I 3/6/2018

To: Sarah White
From: Rich Hayslett
Recorded by: Shockey Consulting, LLC

MEETING SUMMARY

Shockey Consulting facilitated a summit with the Unified Government staff and the project team of Black & Veatch and Shockey Consulting Services on Thursday November 30, 2017. The purpose of the meeting was to develop a 10-year vision and mission statement for the stormwater program, develop 5-year goal statements, and develop a framework for program elements including prioritization. Attendees were encouraged to participate and their comments are documented below.

MEETING ATTENDEES

The meeting was attended by the UG of Wyandotte, Black & Veatch, and Shockey Consulting. The following participants attended the meeting:

UG Wyandotte	Consultant Team
Sarah White	Rich Hayslett
Brent Thompson	Jeff Henson
Jeff Fisher	Derek Cambridge
John Menkhus	Charlie Sievert
Troy Shaw	Sheila Shockey (Shockey)
	Lauren Garrott (Shockey)
	Andrew Smith

SESSION/PLAN ASPIRATIONS

Sheila asked participants to explain their aspiration for the session and what questions would you like answered as a part of this master planning effort. The following were the responses:

- How do we determine who owns what part of the stormwater program?
- How do we better understand the risks?
- How do we better understand what we want the stormwater program to include (flooding, water quality, MS4 compliance, IOCP, system management)?
- How do we set goals that are attainable?
- How do we manage the expectations of rate payers?
- Should we provide the same level of service for two different systems?

- How do we align efforts of the rate study and business plan?
- How do we prioritize the repair of our existing system while addressing other urgent issues?
- How can we work strategically to solve problems before they happen?
- How can we be more cost effective?
- What can we learn by exploring examples of what has worked and what hasn't in other cities?
- How can we find ways to be effective with investments
- How do we create synergy between stormwater, IOCP, sanitary?

These questions will be answered at different stages of the planning process:

- Today through Dec 2017 – Phase 1
- Jan – March 2018 – Phase II
- April + Beyond – Phase III

DESIRED FUTURE DISCUSSION

Sheila asked participants to describe the desired future for the program. She asked where they would like to be in 5 years and in 10 years on the spectrum listed below.

Reactive Program: fix known problem areas only, on a complaint driven basis with limited funding.

Less Reactive Program: make system-wide improvements, use a priority list with limited funding.

Proactive Program: make improvements based upon a risk assessment, repair/replace based upon the likelihood of failure, using dedicated funding source that is adequate.

The advantages and disadvantages of reactive vs. proactive programs were discussed:

Reactive Program Characteristics	***Proactive Program Characteristics***
Poor communication	Prioritization
Emergency	Assess risk
Lives are at risk	Less fear
Political moves are made	Communicate in a concise meaningful way
Limited funding	Dedicated funding

The group agreed the program in 5 years should be moving from less reactive to proactive and in 10 years the program should be nearly to the proactive program stage.

WATER QUALITY FOCUS

The group agreed the desired result for the water quality program is to focus efforts where the biggest impact can be made on waterbodies that people use and that are important to our community. The approach would be to build highly visible projects that achieve multi community benefits focusing efforts on water quality hot spots throughout the system and not just in the combined area. Of course, the UG will also need to meet regulations and these regulatory requirements are evolving.

HEADLINE ACTIVITY

Lauren asked the group to write a headline for 10 years in the future describing the success of the UG stormwater program. The following were the responses:

- UG voters give stormwater program a raise
- Flood improvements in Kansas City Kansas hold back the floodwaters
- UG officials announce expansion to green infrastructure program; residents rejoice
- Jersey Creek now beautiful and attraction
- Kansas City Kansas turns its Overflow Control Program into beatification enhancements
- Kansas City Kansas 10 year milestone in stormwater wastewater overflow control program
- Kansas City Kansas creates center of excellence in northeast Kansas City Kansas
- UG wins highest award at APWA conference for platinum design standards- areas of infrastructure, green engineering
- Jersey creek becomes Kansas City Kansas amenity- solve overflow and flooding while providing both trails, healthy recreation, local restaurants and boutiques
- UG stormwater maintenance department holds special celebration for 150 year old pipe- with routine maintenance and preventative measures, a pipe constructed in 1878 is still in service
- Commissioners says something positive about flooding
- UG implements green infrastructure program to solve flooding and reduces IOCP program costs
- Neighborhood comes together for their 8th annual street and ditch cleanup day
- UG purchases 12 blighted homes, inflow prone areas, and turns into neighborhood park and fishing pond
- Kansas City Kansas benefits of stormwater plan despite monsoon like rains
- Armourdale stays dry (mostly)
- EPA praises Kansas City Kansas stormwater program
- Citizens getting more “bang for the buck” in Kansas City Kansas Plan
- Kansas City Kansas citizens healthier and safer due to plan implementation
- Chiefs lose during heavy downpour; Kansas City Kansas remains dry
- Stormwater plan spends dollars effectively

From those discussions, the group crated a vision, mission statement, and five-year goal statements for the stormwater program.

VISION

Solution-driven, proactive stormwater management for a healthy, vibrant community.

MISSION

The UG stormwater program partners with the public to proactively manage our stormwater system -- benefiting the community and protecting the environment.

We focus our efforts and dedicate resources to reduce flood risk, improve water quality, and maintain our system --providing a safe and healthy community.

GOAL STATEMENTS & PRELIMINARY ACTION STEPS

Regulatory: Integrate MS4 requirement into other Public Works activities, programs, and other UG departments so it is a part of doing business.

Customer Satisfaction: Deliver a well-defined program that the public can understand and that addresses priority problems.

Financial Vitality: Generate adequate revenue to meet needs and effectively balance between long-term debt, asset values, operations and maintenance expenditures, and operating revenues.

Asset Management: Understand condition/costs of assets (life-cycle costing), and develop long-term funding strategy and set priorities.

- Continue to improve system understanding. GIS and Lucity system are a good first step. Need to convert elevations from paper records to electronic. Need to collect and verify the information the GIS system.
- Develop a condition rating and performance rating system.
    - Tie to community rating system and IOCP
    - Define the system.
        - Pipes
        - Pump stations
        - Creeks, lakes, rivers (APWA methodology)
        - Ditches (asses and educate homeowners coordinate with street program, inspection)
    - Use a watershed approach
        - Pick two watersheds. Start in a problem area with outcome focus (Jersey Creek and a rapidly developing area)
- Set level of service desired (consider variable levels that are realistic for the location) Understand different outcomes desired and set different policies and strategy
    - Including different levels of service in CSS and SSS
    - Standards are written for new development- need to be more outcome and watershed based. (MARC new manual update)
    - Involve community- understanding desires

- Establish project priority criteria.
- Overlay other community plans.
    - Look for multiple benefits
    - Coordination
- Identify low-hanging fruit and highly visible projects
- Leverage other pots of funding
    - Consider public-private partnerships
    - Sizing projects upstream to address multiple issues downstream
    - New development- UG builds facilities and changes back to landowners benefiting as watershed develops
        - System Development Charges
        - Impact fees
    - Determine who pays for maintenance, repair, and replacement.

Employee/Staffing: Understand staffing needs and align services to available funding level.

- Fill open positions now with right people and retain quality staff.
- Train staff and provide procedures, technology and tools to succeed.
- Empower staff to take action to solve problems.

Support from elected officials and community: Communicate stormwater challenges and the benefits of a more proactive program to the elected officials and community so that they want to invest at the appropriate level in stormwater.

Jeff Fisher thanked the participants and Black & Veatch for hosting. The session was adjourned at 1 p.m.

KNOWN PROBLEM IDENTIFICATION

WORKSHOP #1 SUMMARY

Unified Government of Wyandotte County and Kansas City, Kansas 197573
Stormwater Master Plan Phase I 3/6/2018

To: Sarah White
From: Rich Hayslett
Recorded by: Jacob Schultze and Laura Adams

MEETING PURPOSE

Known Problems Identification Workshop #1 was held on 7 February 2018, at the Kaw Point Conference Room, Kansas City, Kansas, from 10:30 a.m. to 1 p.m. The purpose of the meeting was to review the known problem areas identified by UG staff, with a focus on flooding, water quality impairment, and failing infrastructure.

Meeting Attendees

The meeting was attended by the UG of Wyandotte, Black & Veatch, and BHC Rhodes. The following participants attended the meeting:

UG Wyandotte	Consultant Team
Sarah White	Rich Hayslett
Brent Thompson	Anna White
Kris Finger	Jacob Schultze
John Menkhus	Laura Adams
Trent Fogelsong	Randy Gorton (BHC)
Kevin Swearengin	Michelle Ballinger (BHC)
Kirk Roland	
Troy Shaw	

MEETING SUMMARY

B&V reviewed the data collection effort and the resulting areas of highest concern. Key discussion points and actions are documented in this summary.

Data Collection

B&V has received historical stormwater report information from the UG, including 20 reports (5 developed after 2000), work order data, asset information in GIS, and the HEC-RAS model for the Turkey Creek. The team has obtained additional relevant information including FEMA floodplain information, available model information used to develop the FEMA floodplains, and has a request for HEC-RAS model for the Missouri and Kansas Rivers developed by the United States Corps of Engineers (USACE).

The UG team highlighted the following:

- Within Lucity, some of the work order data may be skewed because of stormwater work orders generated with any roadway improvement projects. Additionally, UG suggested that within Lucity, priority is reflected by the response time assigned.
- Some additional data sources include a separate spreadsheet which provides a phone number, address, brief description of issue and resolution (provided at mtg) and an asset database that is linked by node numbers and stopped collection in 2012. There will be a few hundred spots that are documented here - this database lists by priority.
- UG has experienced significant failures of CMP. B&V team should evaluate presence of CMP (10+ year) and stormwater issues and target those areas. CMP should not be recommended in the CIP.

Known Stormwater Issues

B&V used the work order data to identify the top 10 watersheds with highest number of work orders from 2013 to the present. The following notes summarize key discussion concerning each of these watersheds:

Turkey Creek (1,512 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- Upper portion is lightly served by storm sewer and has inadequate capacity.
- RR track crossings have insufficient capacity along with erosion issues downstream.
- Projects have been completed that increased storm sewer size at Merriam Lane.
- USACE put in some systems and completed projects in SE area of the watershed.
- Johnson County and KCMO contribute to watershed.

Jersey Creek (1, 158 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- Watershed is a high priority for separation of old pipes with lots of CSO.
- Less than a 1-year event will flood parts of this basin.
- 14th and Washington has visible flooding.
- Last separation projects were 10+ years ago include 27th and Quindaro separation and rain gardens on 17th and Truman. Flooding complaints dramatically decreased.

Mill Creek (976 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- Stony Point had many issues near I-70; significant storm sewer failure.
- 81st and Haskell - White Oaks, Hy-Vee, and north of Parallel is a very old, disconnected system.
- Look west of 38th St. (post WW2 homes) for flooding issues.
- Western part of watershed has choke points near I-70 with culverts that constrict flow.
- Residential areas include drainage ways behind lots.
- State Avenue between 78th and Turner had work orders related to project work.

Connor Creek (938 work orders)

- This basin should not be a focus of this study.

Muncie Creek (233 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- Significant issues in southern end and one or two spots in the northern end.
- Creek is very active – completed project at 57th Street exit.
- No storm systems in portions of this basin.
- Flooding problem at 59th and Speaker.
- TideFlex valves, steel plates, and gates installed to combat internal drainage issues that affect businesses and trailer parks along KS River (57th and Osage).

Splitlog Creek (218 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- Contains combined sewers with limited and aging storm sewer conveyance.
- Lots of problems with grated inlets that are continuously plugged up; however, this maintenance is manageable.

Argentine (172 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- By the river, there are issues with gates not opening and downstream capacity issues.
- Santa Fe Ditch is mostly armored, some storm sewer system, some combined.
- Big hills on the southern side drain to a combined sewer close to Strong Avenue that doesn't provide sufficient capacity. Storm sewers were added to increase capacity.
- When Santa Fe Ditch fills up, water spills out and floods basements.
- Along Swartz: ditching is needed, inlets are not functioning.
- Pump station in the NE corner that pumps to the Ruby Avenue storm sewer and can't keep up with heavy rainfall.
- Pump stations likely to be upgraded because of KC levee work.
- Problem area: 36th to 42nd St. W of Argentine Blvd.
- Basin boundary should be adjusted for Argentine on NW side - it is wrong.
- Kaw Valley Drainage District maintains four 6.5-ft CMPs under the RR - They maintain gates, flood control. Their operation can affect UG. It is a cooperative effort. When it's time to do work, UG and Drainage District work together and cost-share. UG is working to formalize this relationship for the seven levees project.

Marshall Creek (137 work orders)

- This basin should not be a focus of this study.

Fairfax Industrial District (129 work orders)

- This basin should not be a focus of this study.

Little Turkey Tributary North (95 work orders)

- UG confirmed this basin should be a focus of the masterplan.
- We are working on this area currently (between I-70 and State).
- Riverview (80th to 82nd St.) has road flooding south of I-70.
- Smaller streets close to Riverview have flooding.

Additional Areas Identified

- Armourdale watershed (top priority).
- There are some areas with curb and gutter but lacking stormwater sewer inlets (top priority).
- 36th to 42nd, north of Argentine Boulevard (top priority).
- 86th, south of Riverview - The creek had a meander and repairs were made on the sanitary sewer.
- 14th and Osage.
- Take a second look at the area south of I-70.
- Dubb's Dread older neighborhood - north of Piper Creek.
- 49th and Freeman.

DISCUSSION AND ACTION ITEMS

There was agreement to focus the study on key watersheds in the project area. These watersheds include: Armourdale, Little Turkey Tributary North, Argentine, Splitlog, Muncie Creek, Mill Creek, Jersey Creek, and Turkey Creek.

There was a suggestion to classify the existing system in the following categories:

1. Areas with older system that needs to be upgraded
2. Areas without a system
3. Incomplete areas that don't provide adequate capacity.

UG also suggested that the CIP should focus on new systems or extensions in known problem areas.

UG will provide a recent major projects map layer, indicating which problems have already been repaired.

In areas without stormwater control measures, don't assume they have good drainage. Swales and natural drainage systems have been filled in.

B&V will look at vacant parcels in GIS as opportunities for GI.

B&V will follow up with a second focused workshop on confirming a final list of known problem areas.

cc: All Attendees

PHASE 1 WORKSHOP SUMMARY

Unified Government of Wyandotte County and Kansas City, Kansas 197573
Stormwater Master Plan Phase I 4/23/2018

To: Sarah White
From: Laura Adams

MEETING PURPOSE

The Phase I Workshop was scheduled to review the Phase I draft report, define assumptions moving into Phase II and identify overlapping projects that may be prioritized in the 5-Year Capital Improvement Plan. The workshop was held on 16 April 2018, at the Unified Government Public Works office, from 1:30 p.m. to 3:30 p.m.

MEETING ATTENDEES

The meeting was attended by the UG of Wyandotte and Black & Veatch. The following participants attended the meeting:

UG Wyandotte	Consultant Team
Sarah White	Rich Hayslett
Brent Thompson	Charlie Sievert
Jeff Fisher	Derek Cambridge
Troy Shaw	Laura Adams

MEETING SUMMARY

B&V reviewed the Phase I report submittal and key assumptions to confirm its contents before proceeding to Phase II. Key discussion points and action items are documented in these minutes.

DISCUSSION

Review of Phase I Report Submittal

- Brent suggested one main change to the report: All flooding issues should be defined as “drainage problems”.
- Sarah suggested the Stormwater Program Framework should include a prioritization of all the watersheds, rather than just the selected 8 priority watersheds that will be studied in Phase II. There was agreement to move forward with the 8 priority watersheds in Phase II, but ensure that all watersheds are referenced in the Program Framework.
- The UG team also suggested that the 5-Year CIP be defined as a Watershed Approach Study rather than a Masterplan since it is focused on specific areas of interest.
- Sarah will share comments from Jeff Fisher on the draft report before B&V finalizes.

Define Assumptions for Phase II

- There are Eight (8) Selected Watersheds that will be the initial focus of the stormwater program. Priority projects in these watersheds will be evaluated in Phase II. An additional project area along Barber Creek was recommended for inclusion.

- The B&V team discussed the data gaps from the Argentine study and suggested that, based on available information, the budget for Phase II will need to include more field work than originally anticipated. B&V suggested that it will be feasible to evaluate 10-12 projects in Phase II. After review of the probable cost for Argentine and the early estimates from the Rate Study, the team agreed that this number of projects would be a reasonable approach for Phase II.
- B&V suggested that projects be evaluated based on the 5-year event. Troy confirmed that all new development shall meet APWA standards (10-year event). The UG team confirmed that projects in previously developed areas should be evaluated for the 5-year. In the case where 5-year protection is not feasible, recommendations should be developed to meet the highest level of protection feasible. In areas where 5-year protection is not feasible, home buyout options will be evaluated.
- For home buyout evaluation, the average appraisal value associated with each house (for tax purposes) will be used, this data will be sourced from the GIS data provided by the County (parcel_info_py.shp).
- Contingencies for costing shall be consistent with Preliminary Engineering Study assumptions. A 25% general contingency will be applied to opinion of probable costs. Engineering, land/easement acquisition, and other associated costs will also be included.

Identify overlapping projects or planning improvements

The UG suggested that B&V look at road projects planned to identify opportunities for multiple benefits. The UG will provide this information when available.

Communications

The team discussed approaches to communicate the magnitude, the plan forward, the prioritization of stormwater projects in the UG. Additional suggestions will be incorporated in the Communications Plan.

cc: All Attendees

Strategic Asset Management Planning Workshop #1 and Concept Design Workshop

Unified Government of Wyandotte County and Kansas City, Kansas 197573
Stormwater Master Plan Phase II 6/26/2018

To: Sarah White
From: Laura Adams
Recorded by: Justina Gonzalez and Laura Adams

MEETING PURPOSE

The initial Strategic Asset Management Planning (SAMP) Workshop and the Concept Design Workshop were held on 19 June 2018, at the UG City Hall, from 9 a.m. to 1 p.m. The purpose of the SAMP workshop was to establish a foundation for developing an asset management planning framework. The Concept Design workshop provided an overview of key sites that were selected for the 5-year Capital Improvement Plan (CIP). Several conceptual solutions were discussed with the UG to get feedback on recommended concepts and design criteria.

Meeting Attendees

The meeting was attended by the UG of Wyandotte and Black & Veatch. The following participants attended the meeting:

UG Wyandotte	Consultant Team
Sarah White	Charlie Sievert
Brent Thompson	Bryan Dickerson
Trenton Fogelsong	Andrew Smith
Troy Shaw	Laura Adams
Kurt Winters	Justina Gonzalez
Kevin Swearengin	Derek Cambridge
Kirk Roland	
Brendon Grover	

STRATEGIC ASSET MANAGEMENT PLANNING WORKSHOP SUMMARY

B&V discussed components of an asset management program, providing some examples of asset management programs at other stormwater organizations. The team then discussed and defined the components contained within a strategic asset management plan, etc. Three subsequent workshops are scheduled. Objectives and the anticipated homework associated with each of these workshops were discussed. Key highlights from the initial workshop include:

- Asset management essentially lays out a “plan of attack” for addressing the biggest risks in the most cost-efficient manner at the right time
- Allows decision makers to better understand the true cost of ownership of assets

- Gives more confidence in where to invest resources and how to communicate that to the public
- Condition assessment is a key component that will require a consistent methodology and common training on the same process

Subsequent workshops are scheduled as follows:

- Workshop #2, Jun 26 – Alignment of asset management program objectives with strategic plan, identification of key stakeholders, agree on asset registry
- Workshop #3, Jul 10 – Identification of service levels, draft development of risk prioritization methodology
- Workshop #4, Aug 8 – Information management strategies, project identification and prioritization, identification of key future tasks and initiatives, establishing performance metrics to measure program effectiveness

SAMP ACTION ITEMS

Prior to the June 26th workshop, B&V and UG team should complete the following:

- Review revised SWMP (2016)
- Review UG Strategic Plan – http://wycokck.org/Commissioners/Plan.aspx
- Brainstorm on asset (infrastructure) types and current sources of info

CONCEPT DESIGN WORKSHOP SUMMARY

B&V reviewed the project site selection methodology used for and the recommended ten (10) sites that were selected to advance into the 5-Year CIP. The components of the 5-Year CIP were also reviewed. It will contain a list of recommended improvements for high priority problem areas, planning level cost estimates and schedules for projected work. The team acknowledged that the CIP may be modified as work continues through subsequent phases. Due to lack of existing information in the system, the project team collected survey data to characterize the stormwater system (focusing on separate systems) and accurately understand the capacity of existing systems.

In general, APWA 5600 provides the design standard. The following modifications were assumed to develop concept solutions:

- Design to ensure the 5-year, 24-hour event stays below grade (UG)
- 100-year, 24-hour event not evaluated in Phase II; it will be evaluated in Phase III

Concepts at three (3) selected sites were discussed: TURK-4 in Turkey Creek watershed (I-35 North Ramp), MILL-5 in Mill Creek watershed (Georgia and 73rd Terrace), and ARGE-1 in Argentine (along Metropolitan Avenue between 7th and 12th.

TURK-4: The UG noted that this area was evaluated during the USACE project along Turkey Creek. The cost benefit was low because the area lacks structures, and therefore the USACE shifted this project to be the responsibility of the local sponsor. A concept was developed for a “Mission Interceptor” that would mimic Cherokee and Rainbow interceptors and reduce flows going to SW Boulevard.

ARGE-1: The UG noted that a pipe outfalls around 10th Street, conveying a lot of flow. This may be part of the combined system and will be evaluated.

JERS-2 – The UG noted that CSO projects were planned at the following sites: JERS-2, ARMO-5, ARMO-4, and in Argentine. B&V will coordinate to ensure that the concept solution builds upon the IOCP proposal

LTTN-2 – The UG noted that they have looked at buy-outs and providing detention because the culvert passing under I-70 is undersized.

Ditching and swales were recognized as a good fit in some places and the team should identify some good examples. These can be used to provide overland flow paths for larger storm events.

UG instructed B&V to provide connectivity with pipe network rather than retain short reaches of natural channel. Also, to use HDPE pipe in place of RCP through yards.

ACTION ITEMS

UG will provide B&V the following:

1) Proposed Concept for Mission Interceptor (Turkey Creek project: TURK-4)
2) Flooding along Metropolitan Avenue between 7th and 12th, confirm that this is an area of concern (ARGE-1)

B&V will finalize concepts for the ten (10) sites discussed and share with the UG

cc: All Attendees

CIP and POLICY WORKSHOP SUMMARY

Unified Government of Wyandotte County and Kansas City, Kansas 197573
Stormwater Master Plan Phase II 10/29/2018

To: Sarah White
From: Page Burks
Recorded by: Laura Adams

MEETING PURPOSE

The 5-Year CIP and Policy Workshop were held on 8 October 2018, at the UG City Hall, from 11 a.m. to 2 p.m. The purpose of the CIP workshop was to discuss the methodology and priorities for the storm water CIP, present the proposed project locations and preliminary budget. Opportunities for coordination with other projects or entities was also discussed. The Policy workshop focused on the strengths and concerns with the existing UG policies, ordinances, design criteria, and overall program.

MEETING ATTENDEES

The meeting was attended by the UG of Wyandotte and Black & Veatch. The following participants attended the meeting:

UG Wyandotte	Consultant Team
Sarah White	Page Burks
Jeff Fisher	John Handley
Trenton Fogelsong	Andrew Smith
Troy Shaw	Laura Adams
Kurt Winters	
Kevin Swearengin	
Kirk Roland	

CIP WORKSHOP SUMMARY

B&V reviewed the project site selection methodology and the recommended twelve (12) sites that were selected to advance into the 5-Year CIP. These projects represent multiple benefit projects (highly visible, urgent, potential to leverage funding) and high priority projects (roadway and potential structure flooding). Due to lack of existing information at the project sites, the project team collected survey data to characterize the stormwater system (focusing on separate systems) and accurately understand the capacity of existing systems.

In general, APWA 5600 provides the design standard. The following modifications were assumed to develop concept solutions:

- Design to ensure the 5-year, 24-hour event stays below grade (UG)
- 100-year, 24-hour event not evaluated in Phase II; it will be evaluated in Phase III

Conceptual recommended improvements were presented for each site (see powerpoint) and the UG team provided the commentary documented as follows:

ARGE-1:

- Consider when inlets, pipes were last maintained, evaluate Lucity records

ARMO-3:

- Preliminary design might consider modifications to pump station
- Preliminary design should also include a sensitivity analysis of river stage to understand impact of a range of river elevations.

ARMO-5:

- Two properties near 14th and Osage area have used fill to elevate their sites and this may contribute to other flooding issues.
- Common for street maintenance crew to clear from east and west to keep inlets clear
- Existing AT&T vaults provide some storage
- Preliminary design may consider an interceptor alternative, diverting flow from 12th to 14th streets to the west and discharging at one of the existing pump stations.
- Opportunity to integrate green infrastructure

JERS-1:

- Please note in 5-year CIP that this project site, as part of the Fairfax Industrial District, is separately maintained even though UG has combined and storm pipes through the area. Inlets and lateral lines are owned by UG. Main lines are owned by Fairfax. There may be some consideration of cost share for improvements.
- The UG Commissioners want to explore the existing agreement with Fairfax Industrial District to evaluate fee. Further evaluation of jurisdiction will be necessary.

JERS-2:

- Please note an existing 90" overflow at Jersey Creek, from 10th and Walker
- Preliminary design should include evaluation of detention alternative, utilizing vacant and land bank property.

JERS 3:

- A culvert crossing of Jersey Creek near 11th and Troup has been planned and designed but is over budget. Bridge alternative is being considered at this crossing.
- B&V should check the plan for outfall near 11th and Troup. Ensure that the outfall exists and provides connectivity.

LTTN-2:

- Existing channel is concrete lined and in poor condition. Although reports don't indicate erosion, there are stability issues. Dumping in the channel is a maintenance issue. CIP project should be updated to include channel improvements (natural channel).

MILL-3:

- Main homeowner complaints are at areas where pipe discharges onto property and concept improvements should provide continuous system where possible
- Preliminary design will need to include overflow routes

MILL-5 & MILL-6: No commentary.

MUNC-1:

- Swales may be more acceptable in commercial/industrial areas and UG should consider maintenance agreements with owners

TURK-4:

- Preliminary design should include evaluation of interceptor. UG referenced nearby interceptors and associated design storms: Cherokee, 25-year event; Rainbow, 15-year event; Missouri, 15-year event
- Coordination opportunity with KDOT
- Additional areas of concern that were not included in the 5-year CIP include the following:
- 130th and Donahoo
- 26th and Argentine (This may have been resolved with a recent addition of HDPE)
- Santa Fe: KS and 635, commercial areas north of QuikTrip

Prioritization of CIP Projects should account for the following criteria:

- Structure flooding is the highest priority to resolve.
- Roadway flooding should be evaluated based on roadway category. Emergency snow routes and arterial roadway flooding is a high priority.
- Yard flooding should be associated with fewer points.
- Prioritization should consider sewer-shed boundaries and integration opportunities with the IOCP projects
- UG working on a road improvement plan overlay to optimize coordination
- Timing: UG prefers for smaller projects to be interspersed with large projects to demonstrate greater impact across the service areas.

POLICY WORKSHOP SUMMARY

The Policy workshop focused on the strengths and concerns with the existing UG policies, ordinances, design criteria, and overall program. The discussion included evaluation of what is currently working and identification of challenges and gaps.

In summary, the UG staff noted they have an ability to respond to emergencies. There is good coordination between planning and engineering teams although planning standards lack flexibility. The County Engineer is currently revising standards and specifications, including standards of practice for erosion and sediment control. UG is working on a policy to improve street sweeping in areas with heavy street parking. Tracking street sweeping routes in GIS would be helpful.

UG is hiring a Community Engagement Officer and one charge will be to help address homeowner drainage concerns. There is an effort to create a demonstration house as part of the Model Block in the Northeast. Current education and training includes erosion control and BMP training with contractors and designers and sees opportunity to improve public education around any new policy as well as education regarding water quality and dumping,

The team identified the following concerns and opportunities:

- There is a lack of general community/public awareness of the UG stormwater program
- There is a need for improved planning and policy focused on new development and redevelopment:
- Currently, UG allows tremendous flexibility in location and type of construction, not necessarily taking advantage of existing infrastructure
- There is insufficient inspection and enforcement of plans
- There is an opportunity for improved communication between UG field crews and developers to adjust in the field.
- Master plans could be updated to reflect stream setbacks and updates based on planning. Example: 131st Street is functioning as collector but designated as an arterial road in plans. Updated plans should be made publicly accessible.
- Policies and standards could be relevant to their location in the service area. For example, policies in the combined sewer service area may be different than a separate service area.
- Existing policies and standards around natural infrastructure are unclear. There is confusion about ownership and maintenance associated with ditches, driveway drains, culverts, and curbs.
- UG team could have a more defined voluntary buy-out program for flood prone properties to systematically remove people from flooded areas.
- There are not currently adopted standards for Low Impact Development

CIP AND POLICY ACTION ITEMS

B&V will update 5-year CIP and Stormwater Program Framework to reflect input from workshop. Specific notes include the following:

- JERS-1: Please note in 5-year CIP that this project site, as part of the Fairfax Industrial District, is separately maintained even though UG has combined and storm pipes through the area. Inlets and lateral lines are owned by UG. Main lines are owned by Fairfax. There may be some consideration of cost share for improvements.
- JERS-2: Please note an existing 90" overflow at Jersey Creek, from 10th and Walker. Ensure the model represents updated condition at 11th and Troup.
- LTTN-2: Update CIP project to include natural channel improvements upstream of detention basin.
- MILL-3: Provide continuous pipe network in CIP.

cc: All Attendees

.

APPENDIX B – WATERSHED LIST

1. Wolf Creek
2. Piper Creek
3. Wolf Creek Tributary
4. Spring Creek
5. West Mission Creek
6. East Mission Creek
7. Little Kaw Creek
8. Connor Creek
9. Honey Creek
10. Island Creek
11. Island Creek Tributary
12. Upper 9 Mile Creek Tributary
13. 9 Mile Creek
14. Little Snell Creek
15. Marshall Creek
16. Pomeroy Creek
17. Vance Creek
18. Sorter Creek
19. Nearman Creek
20. Eddy Creek
21. Esplanade Creek
22. Fairfax Industrial Creek
23. Betts Creek
24. Little Turkey Creek
25. Little Turkey Creek Tributary South
26. Little Turkey Creek Tributary North
27. Grinter Creek
28. Mill Creek
29. Muncie Creek
30. Brenner Heights Creek
31. Brenner Heights Creek Tributary
32. Jersey Creek
33. Union Pacific Bottoms
34. Little Muncie Creek
35. Santa Fe Bluff
36. Indian Creek
37. Mattoon Creek
38. Splitlog Creek
39. Central Industrial District
40. Timmons Creek
41. Tooley Creek
42. Morris Creek
43. Barber Creek
44. Turner Creek
45. Muncie Bluff
46. Armourdale
47. Argentine
48. Turkey Creek
49. Brush Creek
50. Kansas River Tributary

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APPENDIX C – HISTORICAL STUDIES BY WATERSHED

WATERSHED/ CREEK	INCLUDED IN FEMA FIS?	INCLUDED IN IOCP?	NOTES
Argentine	No	Yes	Pipe information available from IOCP
Armourdale	No	Yes	Pipe information available from IOCP
Betts Creek	Yes	No	2013 HEC-HMS files for 2, 10, 25, 50, 100, 500 year storm events; 2013 HEC-RAS files
Brenner Heights Creek	Yes	Partially	2013 HEC-HMS files for 2, 10, 25, 50, 100, 500 year storm events; 2013 HEC-RAS files; IOCP includes relatively small diameter sewer parallel to creek
Brenner Heights Tributary	Yes	Partially	2013 HEC-HMS files for 2, 10, 25, 50, 100, 500 year storm events; 1977 HEC-2 hardcopy; IOCP includes relatively small diameter sewer parallel to creek
Brush Creek	No	Yes	Pipe information available from IOCP
Central Industrial Dist	No	Yes	Pipe information available from IOCP
Connor Creek	Yes	No	1970s HEC-2 hardcopy; no hydrology files; Black & Veatch performed a flood study using HEC-1 and HEC-RAS in 2003 including a field survey of culverts and bridges along the main streams
Esplanade Creek	No	Yes	Pipe information available from IOCP
East Mission Creek	Yes	No	1970s hardcopy
Fairfax Industrial	No	Yes	Pipe information available from IOCP
Honey Creek	Yes	No	1996 HEC-2 files; no hydrology files
Indian Creek	No	Yes	Limited pipe information available from IOCP
Island Creek	Yes	No	1996 HEC-2 files; no hydrology files
Jersey Creek	No	Yes	Pipe information available from IOCP
Little Turkey Creek	Yes	No	2013 HEC-HMS files for 2, 10, 25, 50, 100 year storm events; 2013 HEC-RAS files
Little Turkey Creek Trib North	Yes	No	1970s HEC-2 hardcopy; no hydrology files

WATERSHED/ CREEK	INCLUDED IN FEMA FIS?	INCLUDED IN IOCP?	NOTES
Marshall Creek	Yes	No	2004 HEC-HMS files for 10, 50, 100, 500 year storm events; 2005 HEC-RAS files
Marshall Creek Trib	Yes	No	2004 HEC-HMS files for 10, 50, 100, 500 year storm events; 2005 HEC-RAS files
Mattoon Creek	No	Yes	Pipe information available from IOCP
Mill Creek	Yes	No	1970s HEC-2 hardcopy; no hydrology files
Muncie Bluff	No	Yes	Pipe information available from IOCP
Muncie Creek	Yes	Partially	2013 HEC-HMS files for 2, 10, 25, 50, 100, 500 year storm events; 1977 HEC-2 hardcopy; IOCP includes relatively small diameter sewer parallel to creek
Santa Fe Bluff	No	Yes	Limited pipe information available from IOCP
Splitlog Creek	No	Yes	Pipe information available from IOCP
Spring Creek	Yes	No	2004 HEC-HMS files for 10, 50, 100, 500 year storm events; 2005 HEC-RAS files
Turkey Creek	Yes	Yes	1970s hardcopy; included as part of the IOCP with pipe information available
Turner Creek	No	Yes	Limited pipe information available from IOCP
West Mission Creek	Yes	No	1970s hardcopy
Wolf Creek	Yes	No	2013 HEC-HMS files for 2, 10, 25, 50, 100, 500 year storm events; 2013 HEC-RAS files
Wolf Creek Tribs	Yes	No	2013 HEC-HMS files for 2, 10, 25, 50, 100, 500 year storm events; 2013 HEC-RAS files
Watersheds with no known stormwater information or much of the watershed is located outside of Wyandotte County limits: 9 Mile Creek, 9 Mile Creek Tributaries, Barber Creek, Brush Creek, Eddy Creek, Grinter Creek, Indian Creek, Kansas River Trib, Little Kaw Creek, Little Snell Creek, Little Muncie Creek, Little Turkey Creek South Trib, Morris Creek, Nearman Creek, Pomeroy Creek, Santa Fe Bluff, Sorter Creek, Timmons Creek, Tooley Creek, Turner Creek, Union Pacific Bottoms, Vance Creek,. Many of these watersheds are small and/or relatively undeveloped.			

APPENDIX D – KNOWN PROBLEM SITE DESCRIPTIONS

This appendix provides detailed descriptions of the known problem areas included in the Deficiency Study. These basins include the following:

- Argentine
- Armourdale
- Jersey Creek
- Little Turkey Tributary North
- Mill Creek
- Muncie Creek
- Turkey Creek
- Splitlog – *The identified problems were related to maintenance practices.*

Table D-1. Known Problem Area Summary

Watershed	Project ID	Description of Flooding
Argentine	ARGE-1	Roadway Flooding, Metropolitan
Argentine	ARGE-2	Roadway Flooding, Argentine
Argentine	ARGE-3	Potential Maintenance Issue
Argentine	ARGE-4	Roadway Flooding, Repetitive Loss
Argentine	ARGE-5	Drainage Issue
Argentine	ARGE-6	Potential Maintenance Issue
Armourdale	ARMO-1	Roadway Flooding, Multiple
Armourdale	ARMO-2	Roadway Flooding, MC Alpine Ave
Armourdale	ARMO-3	Roadway Flooding, Scott Avenue
Armourdale	ARMO-4	Roadway Flooding, Mill Street
Armourdale	ARMO-5	Roadway Flooding, 12th Street and Kansas
Armourdale	ARMO-6	Roadway Flooding, 14th Street
Jersey	JERS-1	Roadway Flooding, Fairfax Trafficway
Jersey	JERS-2	Roadway Flooding, Multiple
Jersey	JERS-3	Potential Maintenance Issue
Jersey	JERS-4	Upstream
Jersey	JERS-5	Upstream
Little Turkey	LTTN-1	Roadway Flooding, Speaker Road
Little Turkey	LTTN-2	Structural Flooding, 83rd Terrace

Watershed	Project ID	Description of Flooding
Little Turkey	LTTN-3	Yard Flooding
Mill	MILL-1	Potential Maintenance Issue
Mill	MILL-2	Open Channel Rehabilitation
Mill	MILL-3	Roadway Flooding, 82nd Terrace
Mill	MILL-4	Erosion and Debris
Mill	MILL-5	Roadway Flooding, 73rd Terrace
Mill	MILL-6	Flooding, 74th Street
Muncie	MUNC-1	Roadway Flooding, Kaw Drive
Muncie	MUNC-2	Open Channel Rehabilitation
Muncie	MUNC-3	Erosion and Debris
Turkey	TURK-1	Roadway Flooding, Clinton
Turkey	TURK-10	Roadway Flooding, 34th Street
Turkey	TURK-11	Roadway Flooding, 51st Street
Turkey	TURK-2	Roadway Flooding, SW Blvd
Turkey	TURK-3	Roadway Flooding, SW Blvd
Turkey	TURK-4	Roadway Flooding, SW Blvd/Mission Road/I-35
Turkey	TURK-5	Roadway Flooding, Mill Street
Turkey	TURK-6	Drainage Issue
Turkey	TURK-7	Potential Maintenance Issue
Turkey	TURK-8	Open Channel Rehabilitation
Turkey	TURK-9	Roadway Flooding, Glenrose Lane

ARGENTINE

Areas within the Argentine Watershed with known flooding problems are presented in Figure D-1.

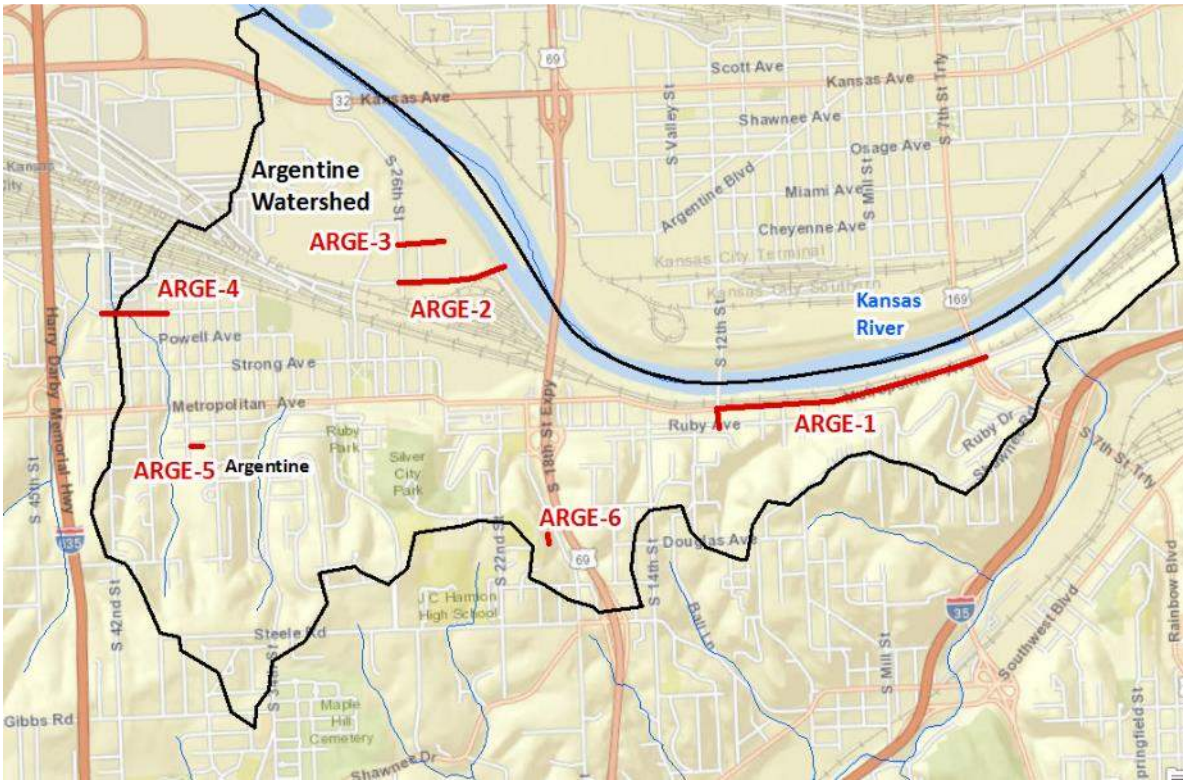

Figure D-1. Known Flooding Problems within Argentine

ARGE-1. *High Priority.* Metropolitan Avenue floods from 7th Street to 12th Street. A natural spring near 12th Street and Ruby Avenue also contributes to icy road conditions in the winter. Neither the IOCP GIS map or the infrastructure GIS map shows a combined sewer or a stormwater sewer in this area. There are smaller culverts crossing under Metropolitan Avenue, then railroad tracks and discharging to the river, presumably through ditches. There is a general lack of culvert size, type, and invert elevation data for these culverts. Therefore, assumptions and/or field investigation are required to perform an analysis.

ARGE-2. *High Priority.* Roadway flooding occurs along Argentine Boulevard from 26th Street to the river, reportedly caused by an undersized combined sewer system. Records indicate sanitary sewer backups have been addressed in this area. Local runoff along Argentine Boulevard is collected by stormwater inlets and pipes which discharge to the river to the east. There is a general lack of pipe size, type, and invert elevation data, requiring assumptions and/or field investigation for analysis.

ARGE-3. *Priority.* Records indicate the system beneath Cheyenne Avenue between 26th Street and 25th Street is in need of repair. There is a 30-inch RCP beneath Cheyenne Avenue, but no apparent inlets

along the street. If that is correct, the flooding issues may be partially resolved by a solution at ARGE-2, or the preferred solution for this area could affect the improvements for ARGE-2.

ARGE-4. *High Priority.* Roadway flooding occurs along Argentine Boulevard between 38th and 42nd streets near the top of the watershed. This area is associated with repetitive loss due to structure flooding as well. There are a few street inlets that appear to discharge to roadside ditches since there are no stormwater pipes leading away from this area according to the GIS maps. The GIS mapping does not provide invert elevations for the pipes; however, data at the street inlets may provide enough information for planning-level modeling purposes.

ARGE-5. *Priority.* Records indicate a drainage issue in the alley near 3723 Ruby Avenue. This area has no known storm inlets or pipes and no combined sewer according to the GIS maps. The infrastructure GIS map indicates there are existing storm pipes located about a block to the east and a block to the north. If a system is extended from these existing pipes, assumptions or field survey may be required to determine their invert elevations.

ARGE-6. *Priority.* Records say the area near 2221 S 18th Street Expressway should be investigated. The GIS maps do not indicate the presence of storm inlets or any pipes in this immediate area.

ARMOURDALE

Areas within the Armourdale watershed with known flooding problems to be studied at this time are shown on Figure D-2. Because of the proximity of documented flooding problems, several problem areas were joined together as single projects for purposes of this Phase I report. When an engineering analysis of these flooding issues occurs, these areas may be separated into multiple projects. The known flooding problems are described below.

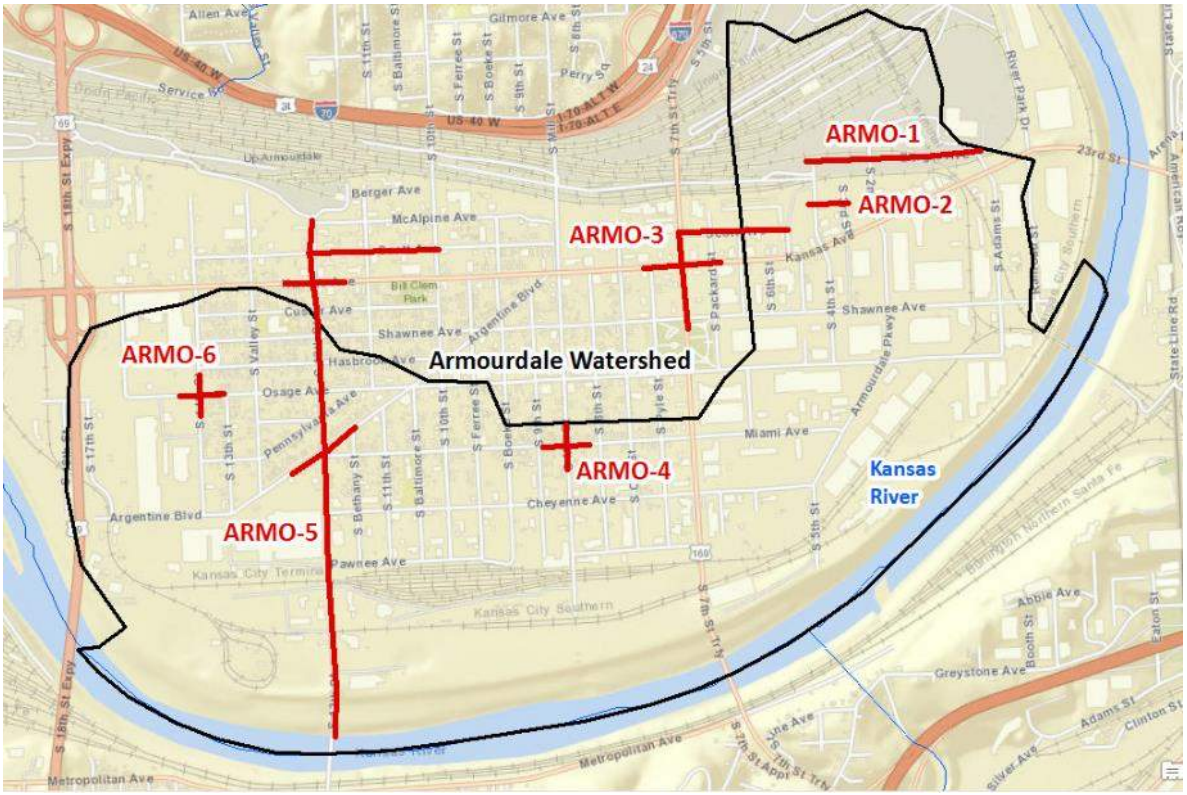

Figure D-2. Known Flooding Problem Areas within Armourdale

ARMO-1. *High Priority.* Road flooding occurs along Berger Avenue from Adams Street to 4th Street. The IOCP GIS map and the current version of the UG infrastructure GIS map both show a 60-inch RCP combined sewer running beneath this area from south to north. Pipe inverts and lengths are consistent between the maps. The current infrastructure GIS mapping also shows a 24-inch RCP stormwater pipe flowing in the opposite direction from north to south where it discharges to the river through a 90-inch RCP stormwater outfall pipe. The available data for these two pipe networks will need to be used to the extent possible to understand how local runoff enters the two drainage systems. It appears stormwater inlets are connected to the stormwater system, and the mapping does not provide evidence of inlets tied to the combined system in this area.

ARMO-2. *High Priority.* Roadway flooding occurs along MC Alpine Avenue between 3rd and 4th streets. This area is near ARMO-1. It appears there is no combined sewer or stormwater system in this area, which will require a field investigation to determine where the storm flows are directed.

ARMO-3. *High Priority.* Roadway flooding occurs along Scott Avenue from 5th to 7th streets and in the intersection of 7th Street Trafficway and Kansas Avenue. The infrastructure GIS map indicates small diameter storm pipes and street inlets in this area, but the connectivity of all of the pipes leading away from this area does not appear to be continuous in the downstream direction. Assumptions about how the storm pipes are connected, or some field investigation, may be required to evaluate this flooding problem.

ARMO-4. *High Priority.* Flooding occurs in the intersection of Mill Street and Miami Avenue. The infrastructure GIS map does not show any stormwater pipes in this area, but both the infrastructure map and the IOCP map show a combined sewer system connected to stormwater inlets (unlike ARMO-1, there is no apparent storm system in this area near ARMO-4). This area was selected for a closer comparison of the IOCP GIS pipe information with the infrastructure GIS file currently under development. For a selected pipe along Mill Street, the IOCP data indicates a 72-inch brick sewer with a downstream invert elevation of 731.73 feet, whereas the infrastructure GIS file indicates a 78-inch brick sewer with a downstream invert elevation of 735.96 feet. Further field investigation will be required.

ARMO-5. *High Priority.* Roadway flooding occurs along 12th Street from McAlpine Avenue to the river, including the intersections of Argentine Boulevard and Kansas Avenue. There is an older brick sewer main beneath 12th Street. Once the existing system and flooding issues are understood, this area may be divided into several projects. This area is a good example of how sewer basins do not always align with watersheds. There is combined sewer data along 12th Street that can be leveraged for a planning-level hydraulic analysis.

ARMO-6. *High Priority.* The intersection of 14th Street and Osage Avenue floods. The infrastructure GIS map indicates some stormwater pipes in this intersection, as well as a combined sewer. But, the infrastructure GIS map does not show these storm pipes as connected to the storm pipes located south of this area. Since there are no invert elevations for the storm pipes, it is unclear if these pipes are connected and allow stormwater to be conveyed to the south, or if the storm pipes in this intersection are connected to the combined sewer which flows toward the east. Assumptions and/or a field visit is necessary to gather data to evaluate the existing conditions.

JERSEY CREEK

Areas within the Jersey Creek Watershed with known flooding problems are shown on Figure D-3. Because of the proximity of documented flooding problems, several problem areas were joined together as single projects for purposes of this Phase I report. When an engineering analysis of these flooding issues occurs, these areas may be separated into multiple projects. The known flooding problems are described below.

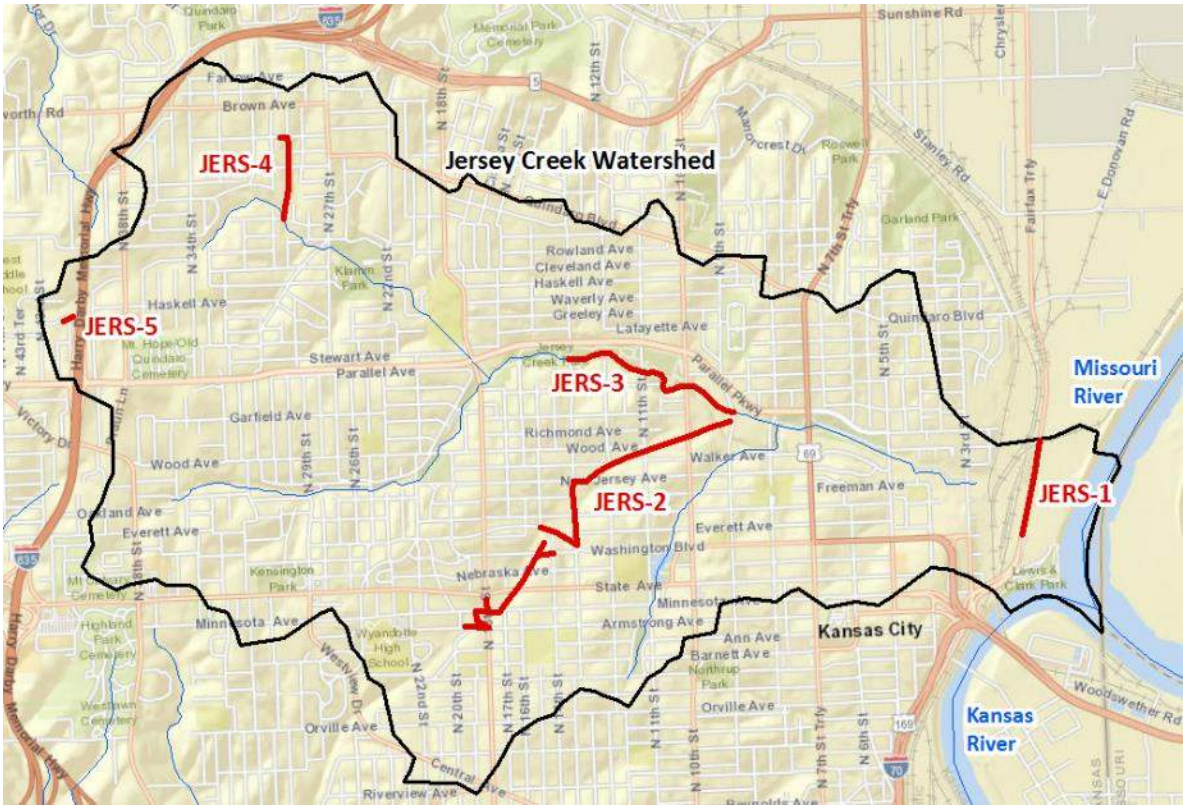

Figure D-3. Known Flooding Problem Areas within Jersey Creek Watershed

JERS-1. *High Priority.* Road flooding occurs along this stretch of Fairfax Trafficway, located at the downstream end of the watershed near the Missouri River. The flooding may be caused by inadequate capacity of the existing sewers during large storm events, inlet capacity of the main sewer pipe collecting flow from Jersey Creek between 3rd Street and the railroad tracks, backwater from the Missouri River, street inlet capacity along Fairfax Trafficway, or any combination of these factors. The IOCP did not evaluate large design storm events, so hydrologic calculations will be required for the entire Jersey Creek watershed to estimate stormwater flows for these events at this location. GIS mapping from the IOCP indicates the main sewer pipe beneath Fairfax Trafficway in the vicinity of this area has dimensions of 222 inches by 210 inches, which is larger than 180 inches listed in the available stormwater system GIS mapping currently being developed. This will need to be resolved with a field survey or desktop assumptions for the planning-level hydraulic modeling.

JERS-2. *Multiple Benefit.* A number of road flooding problems are identified in this area between 9th Street and Armstrong Avenue related to an undersized combined sewer system, including the intersection of 18th Street and Minnesota Avenue and Washington Boulevard between 13th and 15th streets. Once the existing system and flooding issues are understood, this area may be divided into several projects. It appears the IOCP GIS mapping has information for the existing sewer system along the length of this flooding problem. If data gaps or issues are found in this sewer data during the development of the planning level model either a brief field visit or assumptions will be used to develop the model. It is anticipated that the hydraulic model of this branch of the Jersey Creek system will be part of the model developed to analyze JERS-1.

JERS-3. *High Priority.* A channel rehabilitation project is identified for this section of Jersey Creek. Additional discussion with UG and a field visit may be required to determine if this is a maintenance issue or if the channel capacity needs to be evaluated with the hydraulic model. Available topographic mapping will be used to simulate the open channel and this area will also be tied to the hydraulic model of JERS-1.

JERS-4. *Priority.* Records indicate this area requires rehabilitation. The project area is defined as being near 33rd and Lathrop, extending from 3030 N. Lathrop to Jersey Creek. UG's infrastructure GIS mapping indicates a 24-inch sewer in this area, along with some sections of open channel and culverts/pipes beneath roads. The IOCP GIS mapping does not include stormwater conveyance features such open channels and culverts. There is a general lack of pipe invert elevation data that will require assumptions and/or field survey.

JERS-5. *Priority.* A flooding problem is indicated near 41st Street and Waverly Avenue near the top of the watershed. There is a 15-inch diameter pipe in this area, and mapping indicates a 48-inch pipe just downstream of this location beneath Interstate 635. The available mapping does not have the invert elevations of these pipes. With assumptions about the inverts, the planning-level model of this watershed can be extended this far upstream if needed. Alternatively, a separate localized model could be created to evaluate this area.

LITTLE TURKEY TRIBUTARY NORTH

Areas within the Little Turkey Tributary North Watershed with known flooding problems to be studied are shown on Figure D-4. The problems are generally located off the main channel of the creek or upstream of areas studied for the County's FEMA FIS, so the hydrologic and hydraulic models from the FIS may not be useful. The known flooding problems are described below.

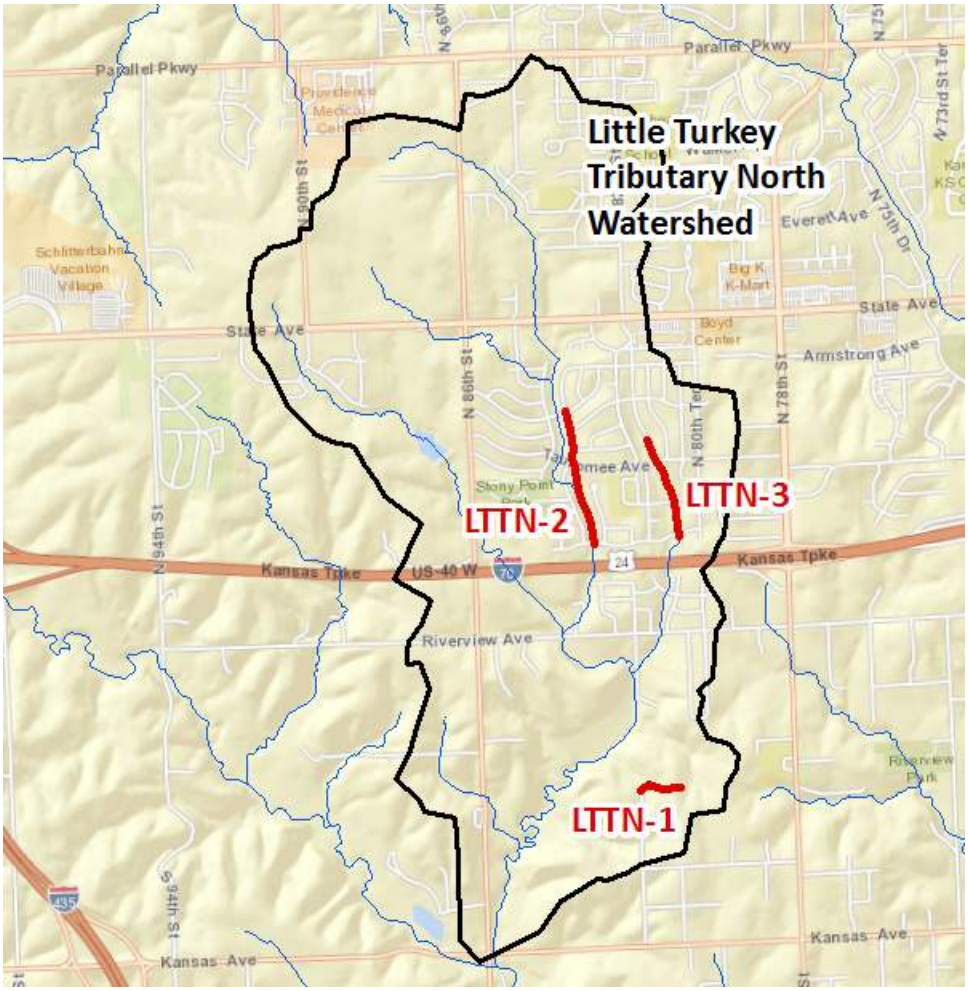

Figure D-4. Known Flooding Problem Areas within Little Turkey Tributary North Watershed

LTTN-1. *High Priority.* Roadway and backyard flooding are noted along Speaker Road just east of 82nd Street. The problem at this location appears to be related to the capacity of several culverts beneath Speaker Road (and potentially the channel between the culverts). The mapping does not indicate the invert elevations of the pipes, so assumptions and/or field survey is required to perform a planning-level hydraulic analysis of this area.

LTTN-2. *Multiple Benefit.* "Structural" flooding (presumably homes) is noted along 83rd Terrace between Isabel Avenue and Ella Avenue. There appears to be a concrete-lined open channel in the backyards of homes in this area with large culverts beneath roads. The infrastructure GIS map does not include invert elevations, but does include some rim elevations and depths for several of the street inlets which could be used along with assumptions and possibly some field survey for planning-level modeling purposes.

LTTN-3. *High Priority.* Yard flooding is occurring along 82nd Street from south of Barnett Avenue to Ella Avenue. It appears there is a concrete-lined open channel in the backyards of homes in this area with large culverts beneath roads. The infrastructure GIS map does not include invert elevations, but does include some rim elevations and depths for several of the street inlets which could be used along with assumptions and possibly some field survey for planning-level modeling purposes. Both LTTN-2 and LTTN-3 happen to be located upstream (north) of Interstate 70; these areas are upstream of the section of Little Turkey Tributary North that was evaluated for the FEMA FIS in the 1970s.

MILL CREEK

Areas within the Mill Creek Watershed with known flooding problems to be studied are shown on Figure D-5. The FEMA FIS hydrology and hydraulic analyses of Mill Creek were performed in the 1970s, so information from the FIS is not likely useful. The known flooding problems are described below.

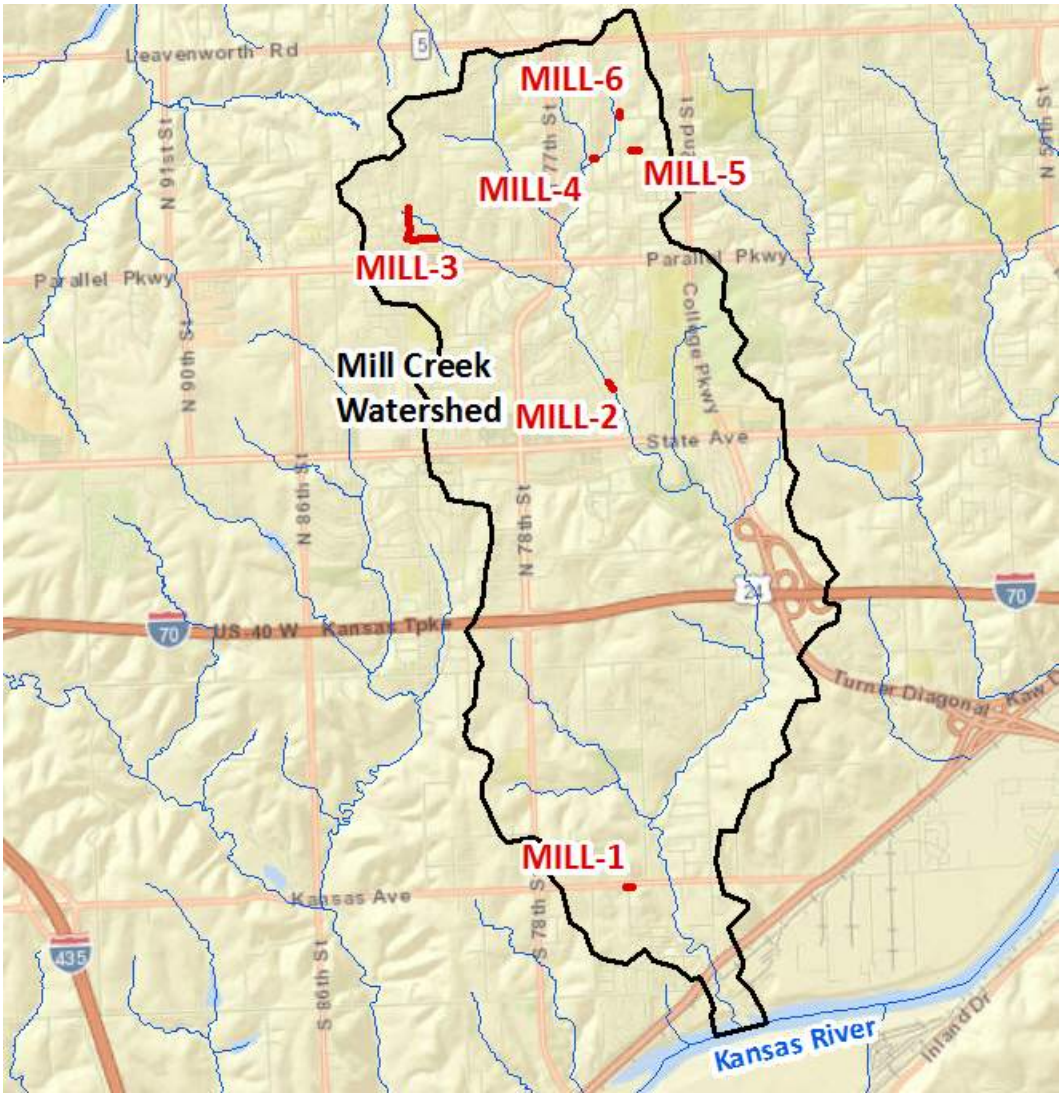

Figure D-5. Known Flooding Problem Areas within Mill Creek Watershed

MILL-1. *Priority.* Records indicate the culvert beneath 74th Terrace, just south of Kansas Avenue, is plugged with sediment. The infrastructure GIS map indicates this culvert is an 18-inch corrugated metal pipe, but invert elevations are not provided. If this problem is beyond a simple maintenance issue, and if a hydraulic evaluation of the conveyance capacity of the culvert and ditches is required, some assumptions and/or field survey will be needed.

MILL-2. *Priority.* Open channel rehabilitation is needed in the vicinity of 74th Street and Everett Avenue. Records indicate the open channel behind homes in this area needs to be rehabilitated. The infrastructure GIS map shows two pipes (36-inch and 48-inch diameters) discharge to the channel in this area. A field visit and further discussion with UG may be required to determine the issues and if hydraulic modeling is required, or if this is a channel maintenance/protection issue as opposed to a channel capacity issue.

MILL-3. *High Priority.* Roadway and yard flooding occurs along 82nd Terrace between Haskell Avenue and Greeley Avenue and along Greeley Avenue between 82nd Terrace and 81st Street. The roadway and yard flooding in this residential area appears to be related to the capacity of the series of street inlets, pipes, and open channels behind homes. The infrastructure GIS map does not indicate the invert elevations of pipes, but has some rim elevations and depths of several of the inlets that could be used for a planning-level hydraulic model. Some field survey may be required to confirm the elevations.

MILL-4. *Priority.* A 72-inch corrugated metal culvert beneath 75th Street Terrace (near 2611 N 75th St Terr) is deteriorated; channel erosion is occurring on the downstream side of the culvert. Further discussion with UG is required to determine if this is a culvert and channel maintenance/protection issue or if it is related to hydraulic capacity. If modeling is needed, some field work is required to determine the culvert invert elevations.

MILL-5. *High Priority.* At 73rd Terrace and Georgia Avenue, there is a flooding problem that needs to be addressed. Records indicate the stormwater system needs to be extended to this area, however, available mapping appears to indicate the presence of a stormwater pipe beneath Georgia Avenue. If so, the evaluation of this area would include confirmation of the capacity and condition of the existing system. The infrastructure GIS map does not indicate the invert elevations of pipes. This map provides rim elevations and depths of several of the inlets that could be used for a planning-level hydraulic model. Some field survey may be required to confirm the elevations.

MILL-6. *High Priority.* Records indicate the need to extend the stormwater system to the area near 74th Street and Yecker Avenue. There is an open channel just west of 74th Street that may be contributing to the flooding issue. The infrastructure GIS map does not indicate the presence of street inlets in this residential area. There are several culverts that apparently convey water from ditches beneath the street. Invert elevations of these culverts are unknown, so some field survey may be needed, or assumptions can be made using available topographic information.

MUNCIE CREEK

Areas within the Muncie Creek Watershed with known flooding problems are shown on Figure D-6. The problems are generally located off the main channel of the creek or upstream of areas studied for the County's FEMA FIS, so the hydrologic and hydraulic models from the FIS may only be marginally useful.

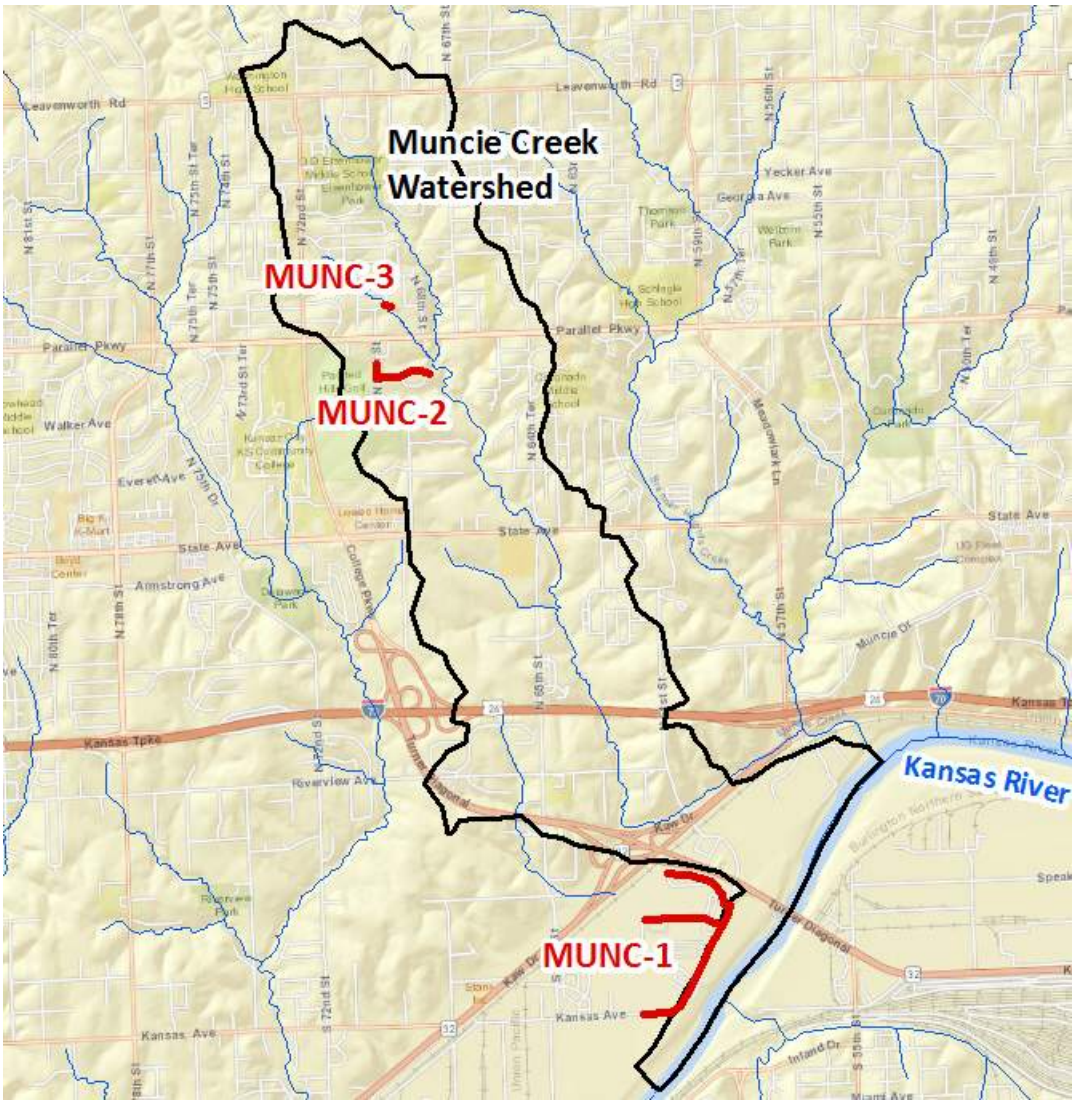

Figure D-6. Known Flooding Problem Areas within Muncie Creek Watershed

MUNC-1. *High Priority.* Roadway flooding occurs in this area south of Kaw Drive within Muncie Bottoms near the river. Records indicate the stormwater system needs to be extended into this area, possibly replacing what appear to be culverts under Kansas Avenue and Royal Drive. The infrastructure GIS map of the culverts and inlets along Kansas Avenue does not have invert elevations. Assumptions and/or field survey will be required for hydraulic analysis.

MUNC-2. *Priority.* Records indicate an open channel needs to be rehabilitated behind homes along Garfield Avenue to the east of 70th Street. A field visit and further discussion with UG may be required to determine the issues and whether hydraulic modeling is required. This is a wooded area, so the topographic data should be reviewed carefully to determine if the channel cross section accurately represents conditions for planning purposes. Otherwise, a limited field survey may be necessary.

MUNC-3. *Priority.* Stream flooding deposits debris on the property at 6915 Greeley Avenue, and the riprap protecting the channel has been washed away. Further discussion with UG and potentially a site visit is needed to determine the issues with erosion and debris following storm events to determine whether hydrologic and hydraulic modeling is required to evaluate channel and culvert capacity. If modeling is required, the infrastructure GIS map does not have invert elevations for the culvert beneath Greeley Avenue; so assumptions and/or field survey are required for hydraulic analysis. This is a tributary of Muncie Creek, so the FEMA FIS study would not have included hydraulic modeling of this area.

TURKEY CREEK

Areas within the Turkey Creek Watershed with known flooding problems are shown in the figure below. The known flooding problems highlighted in the figure are described below.

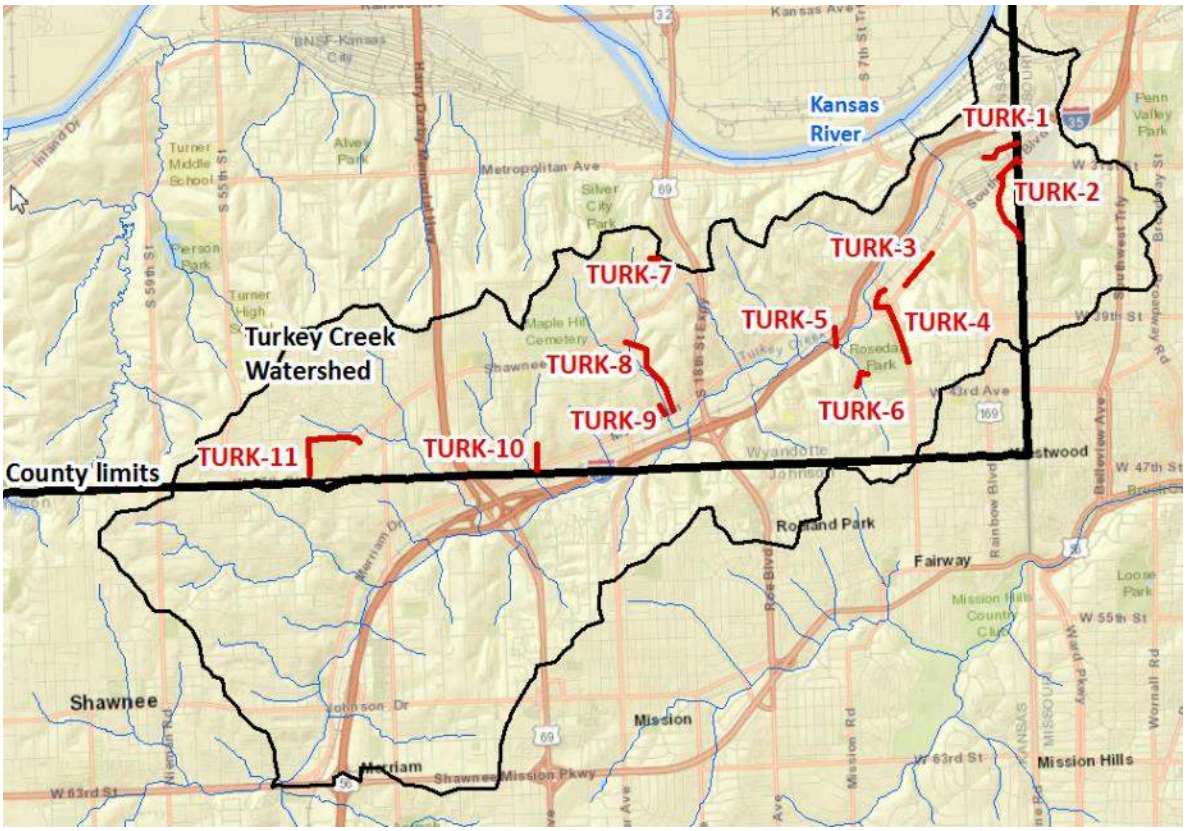

Figure D-7. Known Flooding Problem Areas within Turkey Creek Watershed

TURK-1. *High Priority.* Roadway flooding occurs along Clinton Street near the downstream end of the Turkey Creek Watershed within Wyandotte County. The IOCP did not evaluate large design storm events, so hydrologic calculations will be required for the entire Turkey Creek watershed to estimate stormwater flows for these events at this location. The infrastructure GIS map indicates the presence of several storm inlets and pipes in this area. There is a general lack of information about pipe sizes and invert elevations, and the GIS mapping stops at the County line at the east end of this flooding problem area. It is unclear if the local stormwater flow is currently conveyed east or west from this area, but it appears the stormwater pipes convey flow to the east across the County line. The open channel of Turkey Creek is located approximately ½ mile to the west of this area, which may provide one solution for alleviating this road flooding problem as opposed to a solution that would involve going outside of Wyandotte County or beneath Interstate 35. Additional comments about this area are provided below for TURK-2.

TURK-2. *High Priority.* Roadway flooding occurs from the intersection of Southwest Boulevard and 31st Street, extending to the south along Southwest Boulevard to Eaton Street and along Eaton Street to Chester Avenue. Both TURK-1 and TURK-2 are situated in a highly developed industrial and commercial area. There is available information about pipe networks in Kansas City that may need to be evaluated to understand the current flooding problems at TURK-1 and TURK-2, although the UG may decide to keep the recommended improvements within Wyandotte County for this planning-level phase. Within Wyandotte County, there is a general lack of information about storm pipe invert elevations. Assumptions and some field survey information will likely be needed for this study.

TURK-3. *High Priority.* Roadway flooding occurs along Southwest Boulevard from Lincoln Street to 5th Street. Street inlets along Southwest Boulevard are connected to several 36-inch brick storm pipes connected to a 60-inch brick pipe that discharges to Turkey Creek just north of this known road flooding problem. Similar to other storm pipes in this area, there is a general lack of pipe invert elevation data. The ability to use data at the street inlets appears to be limited because the inlets appear to be offset from the main storm sewer. If stormwater is conveyed to the north to Turkey Creek, it is noted that the infrastructure GIS map shows a 60-inch pipe entering this area from the south and tying into a smaller 36-inch pipe at the intersection of Southwest Boulevard and Cherokee Street. Assumptions and/or some amount of field survey will be needed to evaluate this area.

TURK-4. *Multiple Benefit.* Roadway flooding occurs near the Southwest Boulevard/Mission Road interchange, extending south along Mission Road to 40th Terrace. The GIS mapping indicates many stormwater inlets connected to stormwater pipes beneath the Southwest Boulevard/Mission Road interchange. These stormwater pipes discharge to the west into Turkey Creek. Again, there is limited information in the infrastructure GIS file for the inverts elevations of these storm pipes, so assumptions and/or field survey will be needed to establish the profiles of the existing stormwater system for hydraulic analysis purposes.

TURK-5. *High Priority.* Roadway flooding occurs on Mill Street between Seminary Street and Lake Avenue (beneath I-35). This roadway flooding problem is near the confluence of Turkey Creek with one of its tributaries, on Mill Street below I-35. The infrastructure GIS map shows storm inlets and pipes conveying stormwater runoff from the north beneath I-35 to Turkey Creek. There appears to be sufficient planning-level data for this area.

TURK-6. *Priority.* A natural spring causes issues near the intersection of Puckett Road and Rosedale Park Drive. There is an existing culvert beneath the intersection conveying flow from a tributary to Turkey Creek. The invert elevations of this culvert are not available.

TURK-7. *Priority.* Records indicate the need to investigate the repair or replacement of the storm sewer system near 21st Place and Shearer Road. The infrastructure GIS map does not show any stormwater inlets or pipes in this area, and therefore the improvement may require an extension of the system to this location.

TURK-8. *High Priority.* The open channel along Espenlaub Lane from Shawnee Drive to Merriam Lane needs rehabilitation. Records indicate this stormwater issue is related to the need for rehabilitation of the open channel along this a tributary to Turkey Creek. To better understand the issue (capacity, erosion, or other), a field visit and further discussion with UG may be required.

TURK-9. *High Priority.* Roadway flooding occurs along Glenrose Lane from Forest Lane to Merriam Lane. The roadway flooding at this intersection is near the downstream end of the channel issues for TURK-8. It is possible that the culvert/channel conveying the tributary flow beneath Merriam Lane, and/or the stormwater inlets and pipes in the intersection of Merriam and Glenrose lanes are undersized. Again, the infrastructure GIS file does not include invert elevations of pipes. Assumptions and/or field survey will be required for hydraulic analysis.

TURK-10. *High Priority.* Roadway flooding occurs along 34th Street between Oliver Avenue and Merriam Lane. This problem area is similar to TURK-9 but along a different tributary of Turkey Creek. It is possible that the roadway flooding here is related to an undersized culvert/channel conveying the tributary flow beneath Merriam Lane, or the stormwater inlets and pipes along 34th Street are undersized. Again, the infrastructure GIS file does not include invert elevations of pipes. Assumptions and/or field survey will be required for hydraulic analysis.

TURK-11. *High Priority.* Roadway flooding occurs along 51st Street south of Locust Street and along Locust Street between 51st Street and Shawnee Drive. The GIS mapping shows very few stormwater inlets and pipes, and no combined sewer, surrounding this elementary school. The solution may require the extension of the system into this area, tying into downstream system for which available pipe data will need to be reviewed once it is determined which direction to convey the flow.

APPENDIX E - RECOMMENDED PROJECT DETAILS

This appendix provides detailed descriptions of existing conditions and recommended improvements for the 12 sites that were advanced to concept design.

ARGE-1

Site ARGE-1 is directly adjacent to the Kansas River and is bordered by S 7th Street Trafficway to the east and S 12th Street to the west.

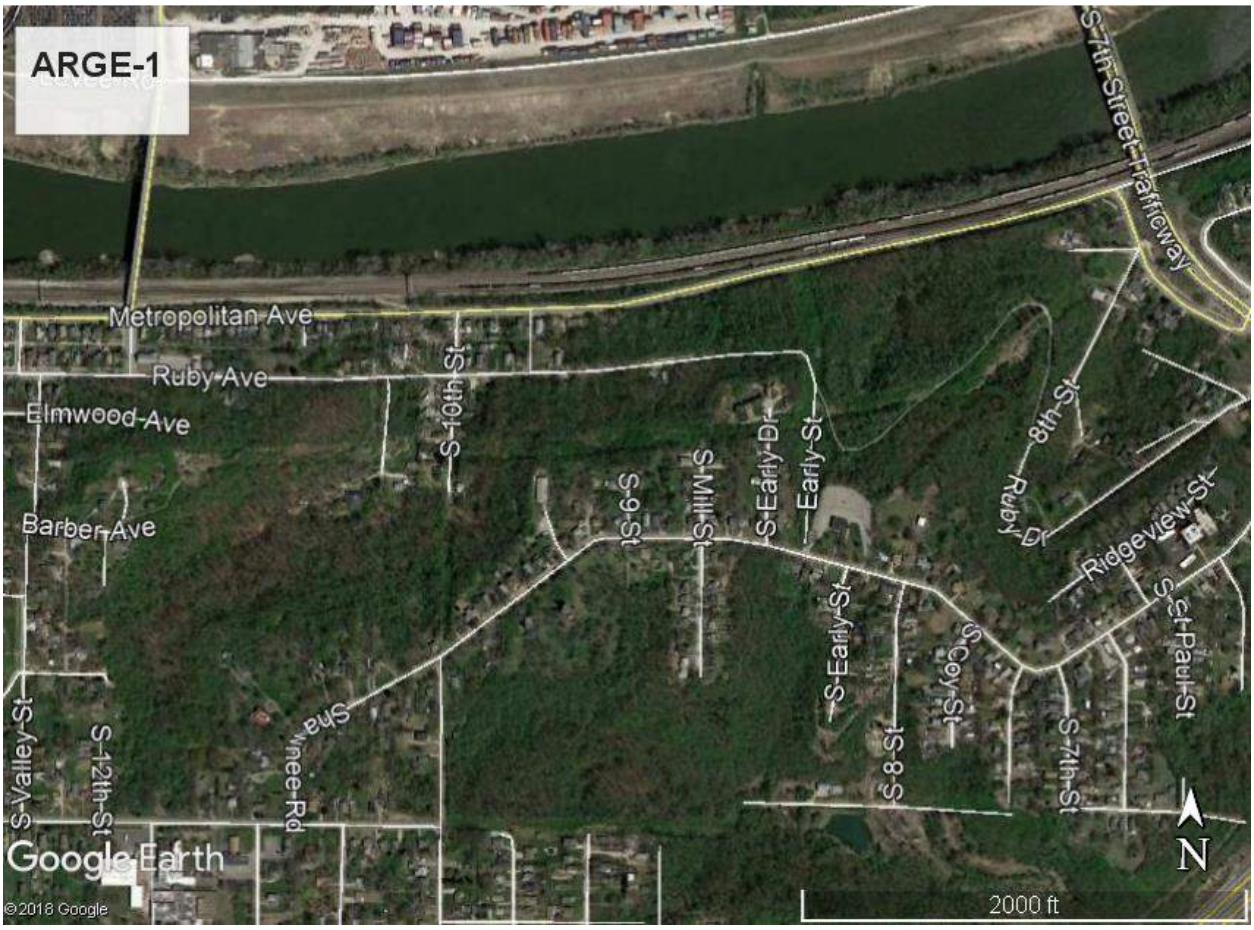

Figure E-1. Site ARGE-1 Location.

Existing Condition

Drainage issues were documented primarily along Metropolitan Avenue. Reported issues also include a natural spring near 12th Street and Ruby Avenue which contributes to icy conditions during the winter. The UG noted that a pipe outfalls in the vicinity of 10th Street and conveys a significant amount of flow, however, a pipe network upstream of the existing outfall was not documented in the field evaluation. Survey confirmed the lack of a combined sewer or stormwater sewer along Metropolitan Avenue. The elevation of Metropolitan Avenue is higher than the BNSF railroad, located north of the avenue. Several culverts cross under Metropolitan Avenue and BNSF railroad tracks, conveying flow to the Kansas River, as shown in Figure E-1. The drainage area to this site is approximately 240 acres.

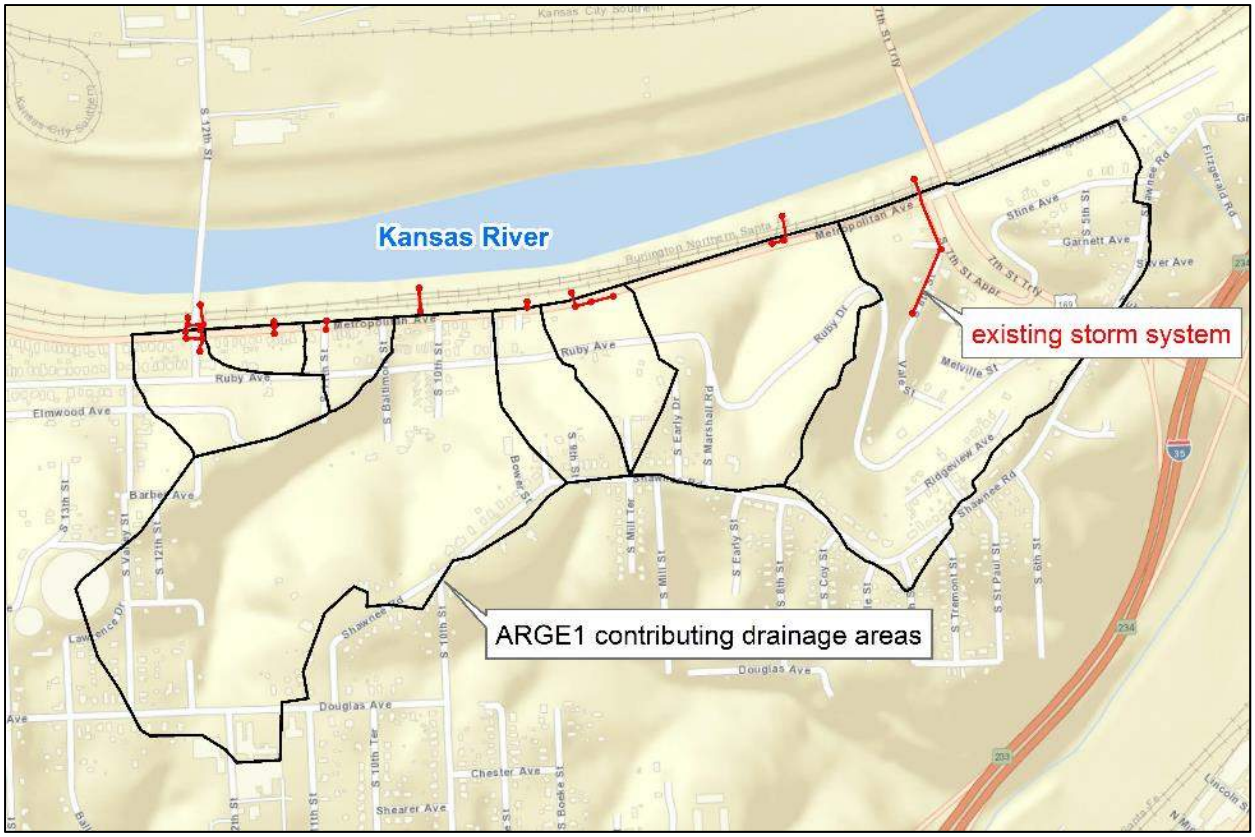

Figure E-2. ARGE-1 Existing Stormwater Network.

Additionally, field investigation documented deposition within the stormwater infrastructure as shown on E-3.

Figure E-3. ARGE-1 Survey Photo of Clogged Structure.

Proposed Solution

To convey the 5-year, 24-hour storm event within this project area, additional pipe and inlet capacity is necessary, as shown in Figure E-4 and E-5. Additional pipe lengths were established along Metropolitan Avenue to provide connectivity to proposed inlet capacity. For the purposes of estimating cost, a standard curb inlet capacity of 5 cfs/inlet was assumed. However, due to the significant capacity required, clusters of inlets or area inlets may be considered in preliminary design.

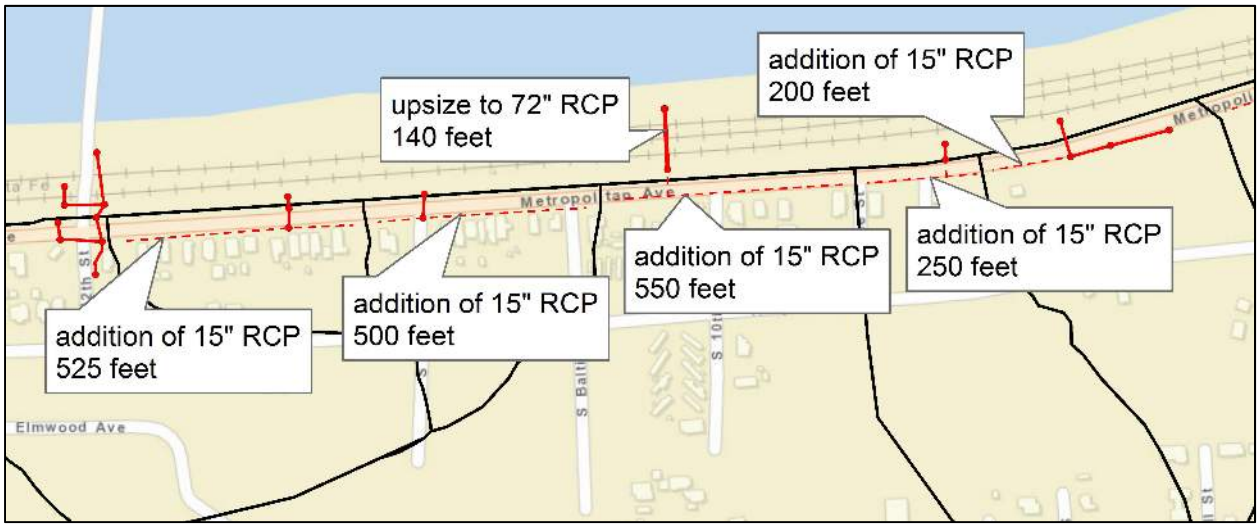

Figure E-4. ARGE-1 Proposed Stormwater Network Upsizing for 5-Year Event, West Section.

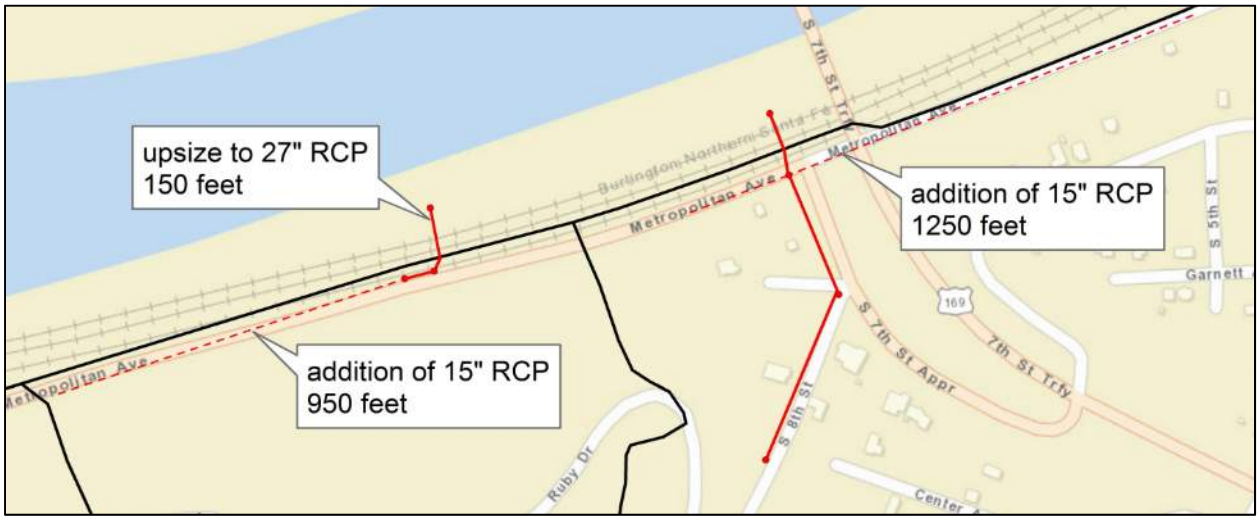

Figure E-5. ARGE-1 Proposed Stormwater Network Upsizing for 5-Year Event, East Section.

ARMO-3

Site ARMO-3 is located in the Armourdale neighborhood, adjacent to the Kansas River. This site includes the intersection of 7th Street Trafficway and Kansas Avenue, as well as Scott Avenue, as shown in Figure E-6.

Figure E-6. Site ARMO-3 Location.

Existing Condition

Roadway flooding occurs along Scott Avenue from 5th to 7th streets and in the intersection of 7th Street Trafficway and Kansas Avenue. The existing network at ARMO-3, shown in Figure E-7, is not continuous along the 7th Street Trafficway. At Packard Street, the system collects surface flows and piped flow from the north. This system conveys stormwater eastward to the Kansas River along Shawnee Avenue via parallel pipes. These pipes terminate at a junction near Railroad Street, transitioning to a 72" RCP. Flow from this system is discharged to the Kansas River via Pump Station No. 10.

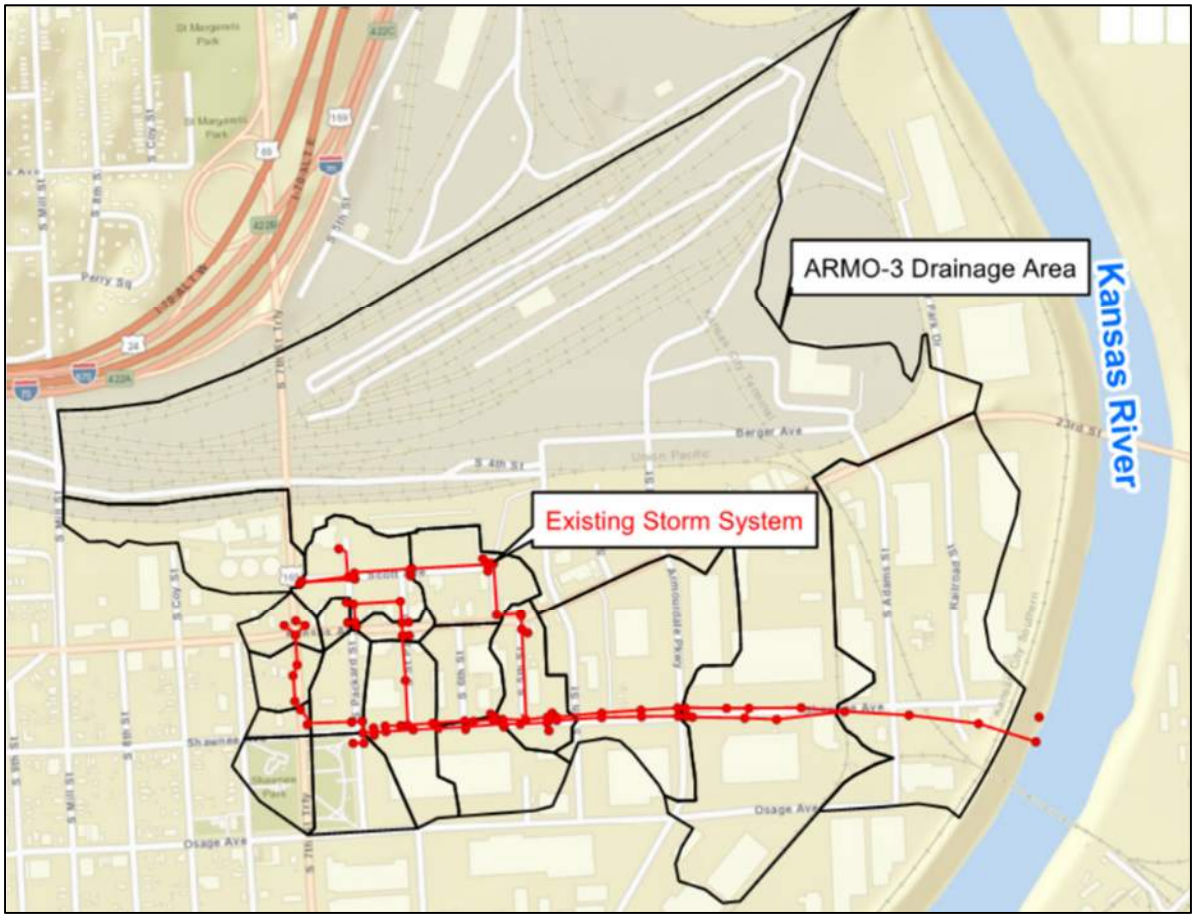

Figure E-7. ARMO-3 Existing Stormwater Network.

Proposed Solution

To capture and convey the 5-year, 24-hour storm event below ground to alleviate street flooding in this area, the pipe and inlet capacity along 7th Street Trafficway, Scott Avenue, and Shawnee Avenue should be increased. Recommended inlet capacity was established by peak flows and assuming a maximum individual inlet capacity of 5 cfs. In preliminary design, optimal configuration of inlets should be determined. Undersized infrastructure downstream from this location contributes significantly to flooding along Scott Avenue, and therefore, this area was included in the proposed improvement. The following figures present the extent of proposed improvements.

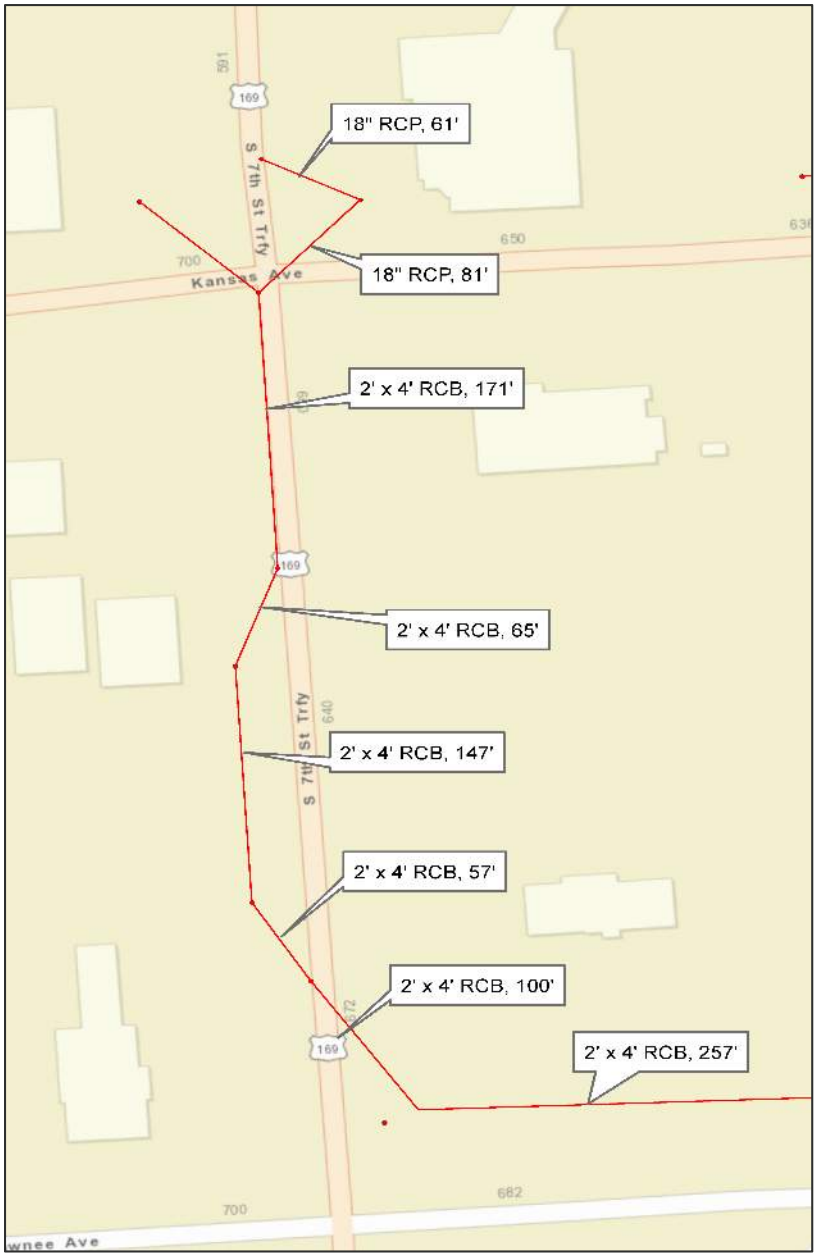

Figure E-8. Proposed Improvements along South 7th Street Trafficway.

Figure E-9. Proposed improvements along Scott Avenue.

Figure E-10. Proposed Improvements along Shawnee Avenue.

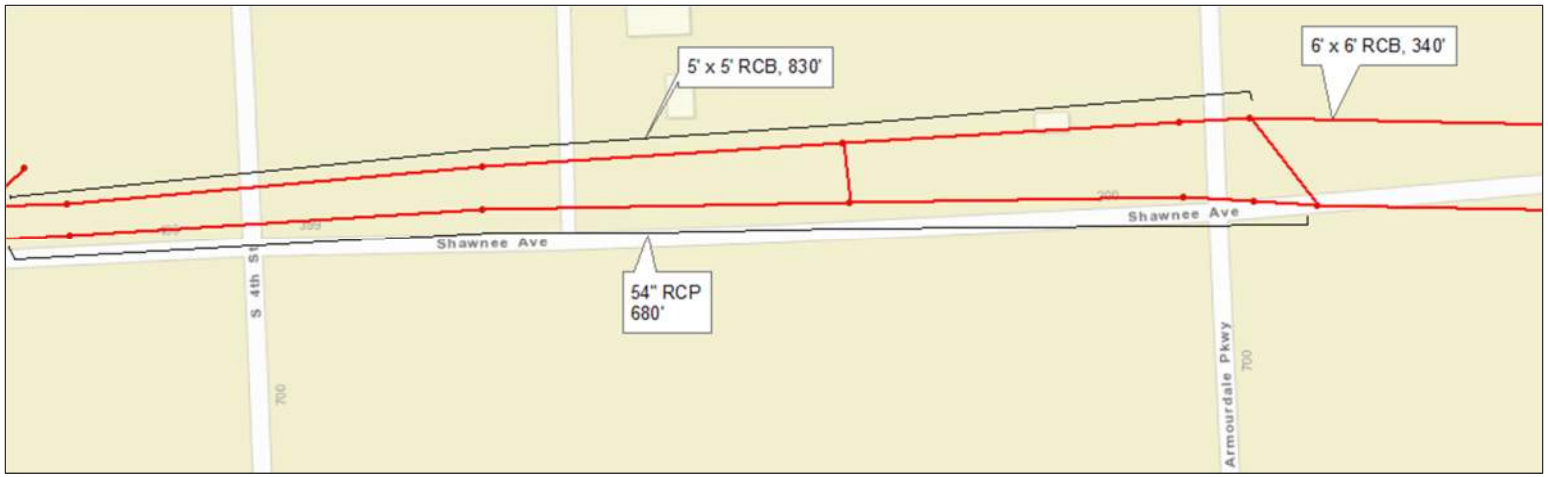

Figure E-11. Proposed Improvements along Shawnee Avenue.

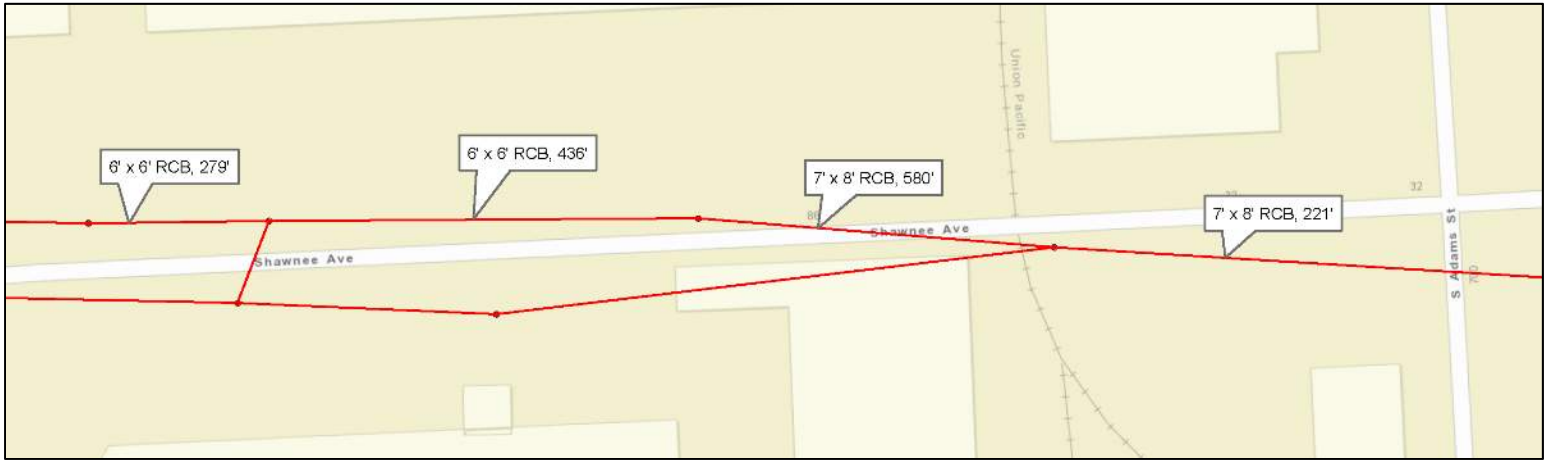

Figure E-12. Proposed Improvements along Shawnee Avenue.

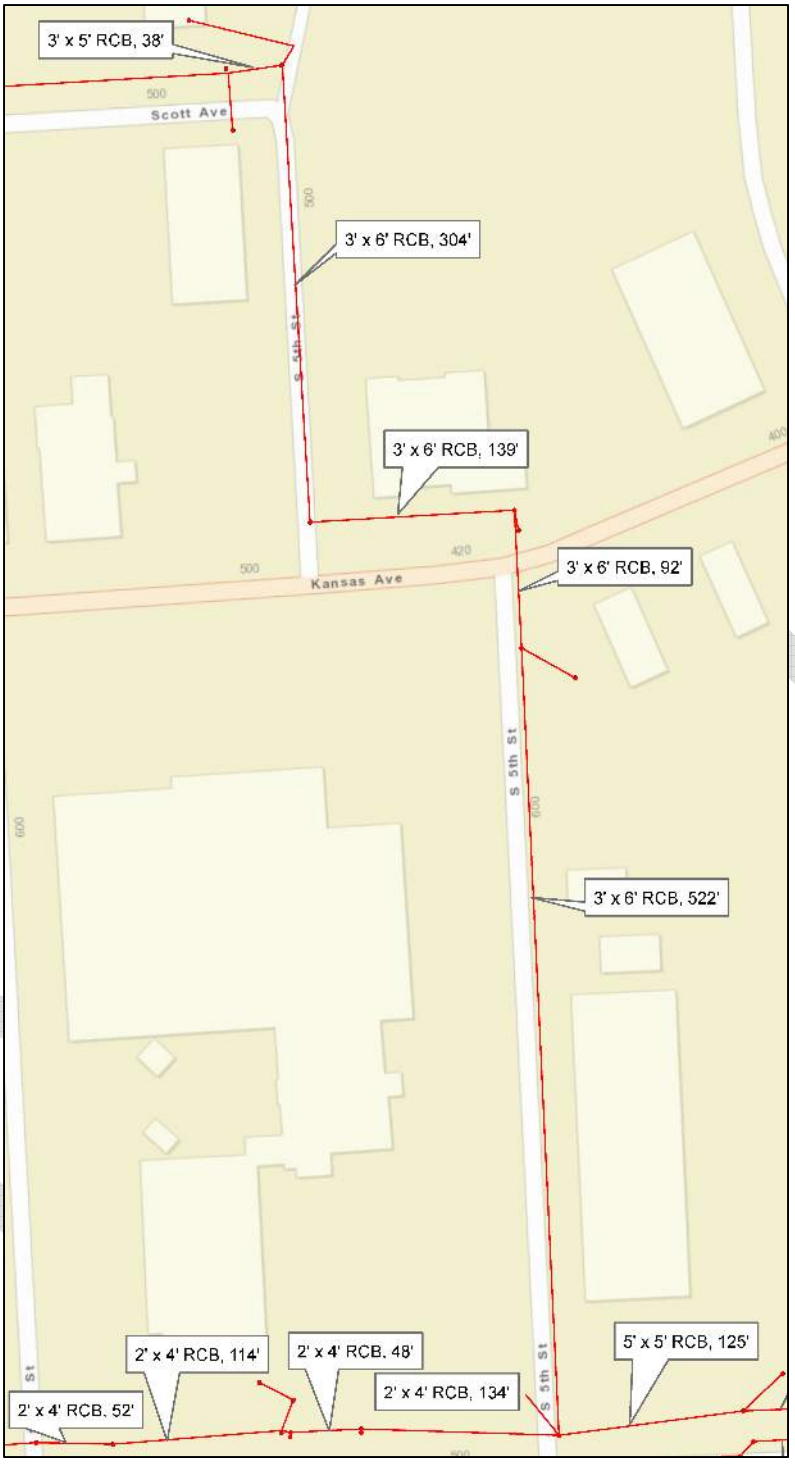

Figure E-13. Proposed Improvements along South 5th Street.

ARMO-5

Site ARMO-5 is located in the Armourdale neighborhood, adjacent to the Kansas River. The site extends along South 12th Street and is bounded on the north by McAlpine Avenue, two blocks north of Kansas Avenue. This general area is presented in Figure E-14.

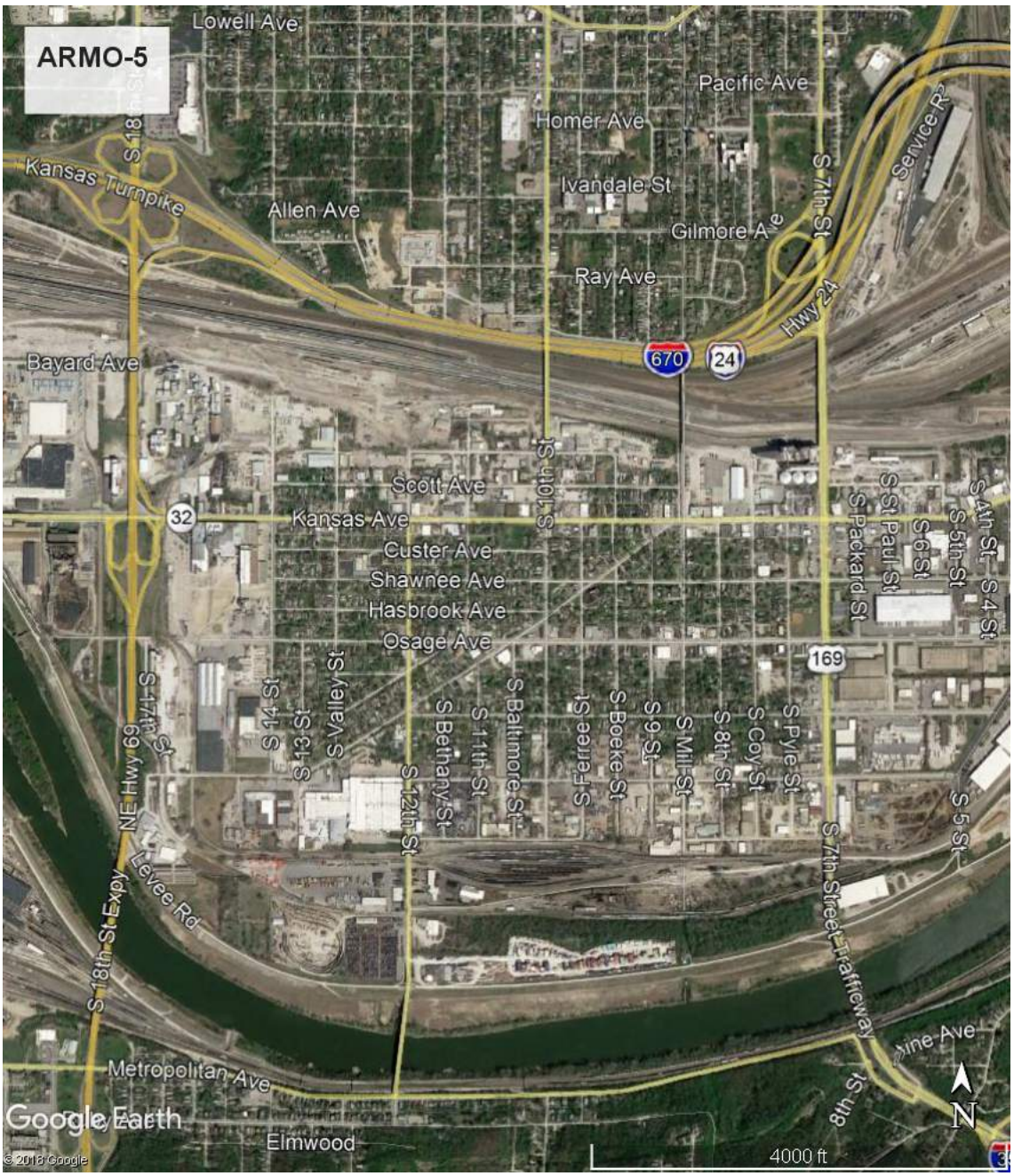

Figure E-14. Site ARMO-5 Location.

Existing Condition

Flooding has been documented along 12th Street from McAlpine Avenue to the Kansas River. The intersections of 12th Street with Argentine Boulevard and Kansas Avenue are included within the extents. The existing system along 12th Street consists of an older brick sewer main that conveys combined sewer and stormwater flows. The drainage area for this project is approximately 613 acres.

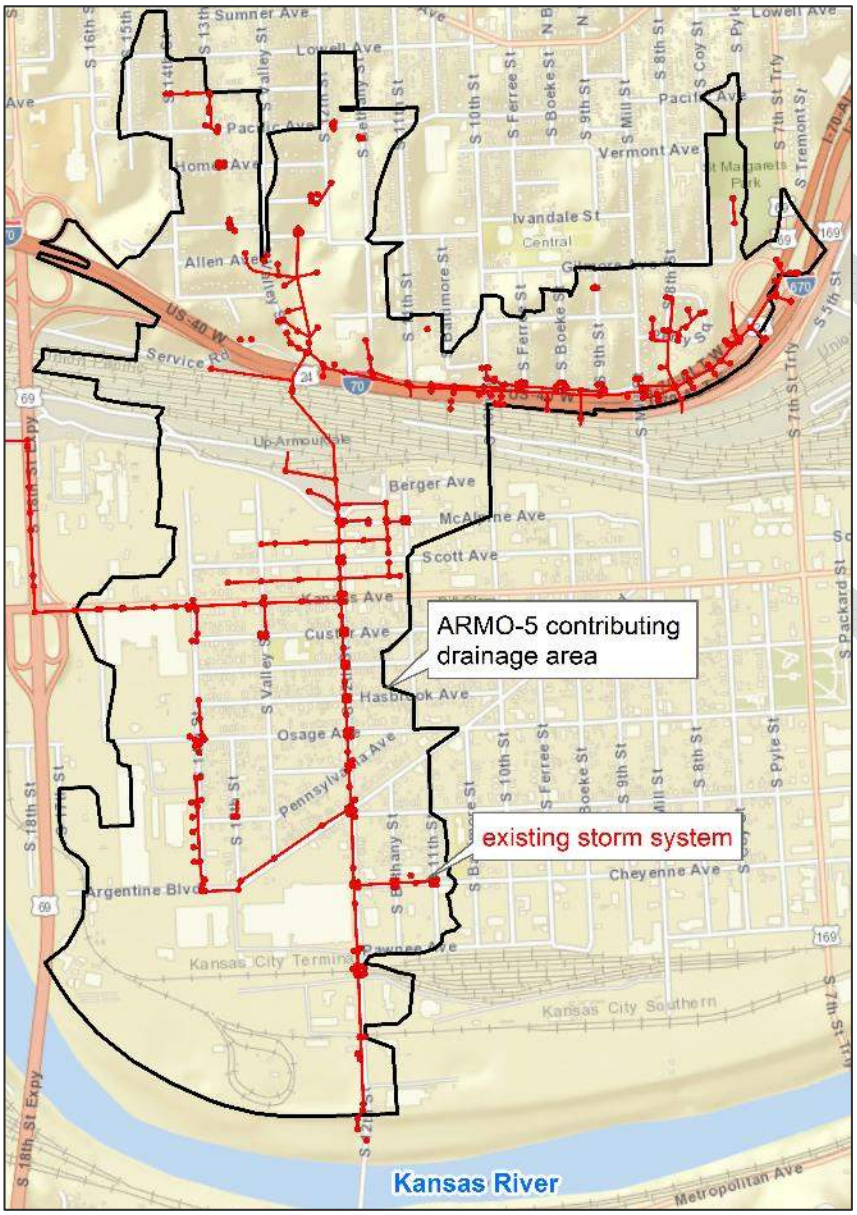

Figure E-15. ARMO-5 Existing Stormwater Network.

Proposed Solution

To convey the 5-year, 24-hour storm event and alleviate flooding along South 12th Street, a new stormwater pipe and inlet capacity is required, as shown in the figures below. For the purposes of this concept, contributing pipe networks were assumed to capture and convey the 5-year event. Additional inlet capacity will be necessary to convey storm flows to the new pipe system. Assuming 5 cfs/inlet, a total of 170 new inlets are distributed along the network. This project site may be divided into multiple projects; these projects should be initiated at the downstream end. Additionally, this site overlaps a recommended project in the Integrated Overflow Control Plan. This corridor presents challenges related to utility conflicts, and the presence of the combined sewer.

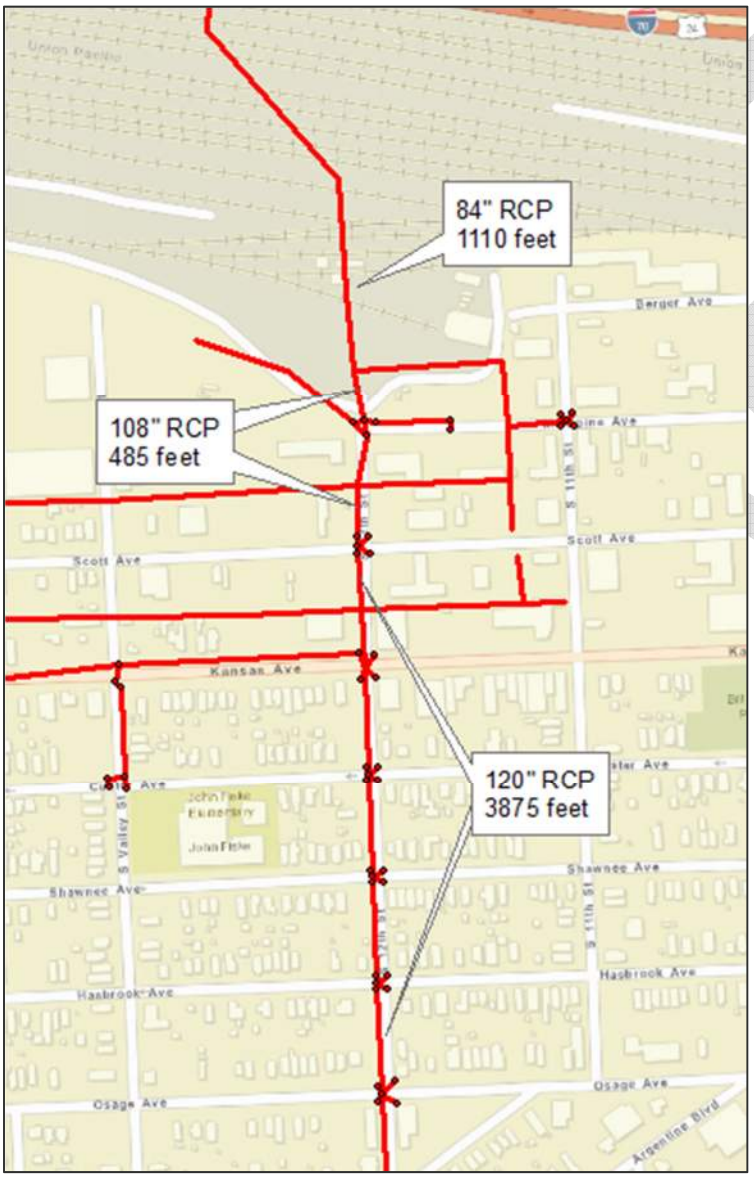

Figure E-16. ARMO-5 Proposed Stormwater Network Upsizing for 5-Year Event, North Section.

Figure E-17. ARMO-5 Proposed Stormwater Network Upsizing for 5-Year Event, South Section.

JERS-1

Site JERS-1 is located the downstream portion of the Jersey Creek watershed, adjacent to the Missouri River. This general area is presented in Figure E-18 and is predominantly industrial. Jersey Creek is a combined sewer watershed; however, the Integrated Overflow Control Plan did not evaluate or propose solutions associated with the 5-year storm event for this area.

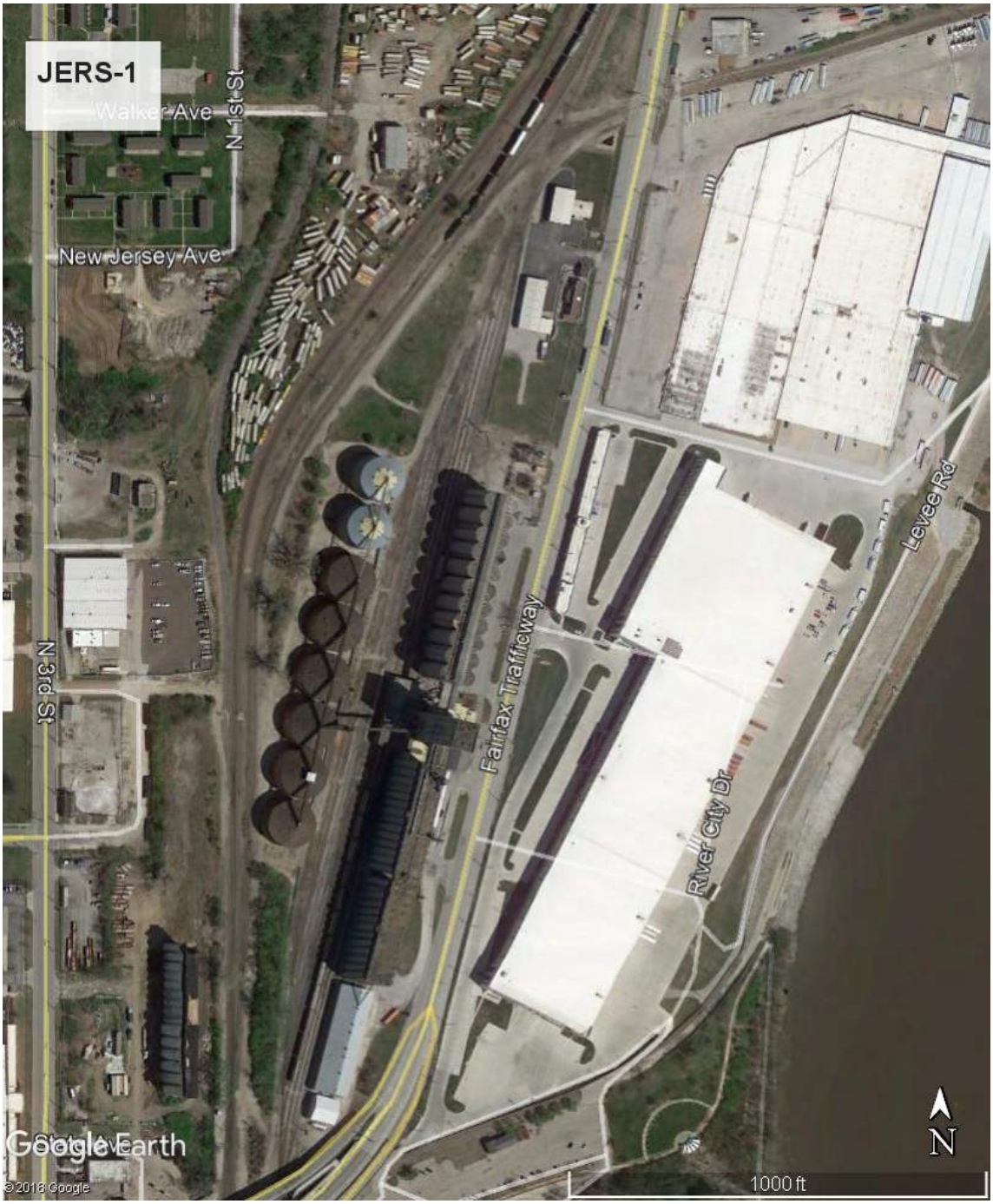

Figure E-18. JERS-1 Project Location

Existing Condition

Roadway flooding has been documented along Fairfax Trafficway and was confirmed in a model of the system. There are two main causes: On the western portion of the system, there is a lack of inlet capacity. The system along Fairfax provides adequate inlet capacity but lacks pipe capacity to convey the 5-year, 24-hour event. Survey data was collected for the accessible area, but it should be noted that some invert elevations were assumed.

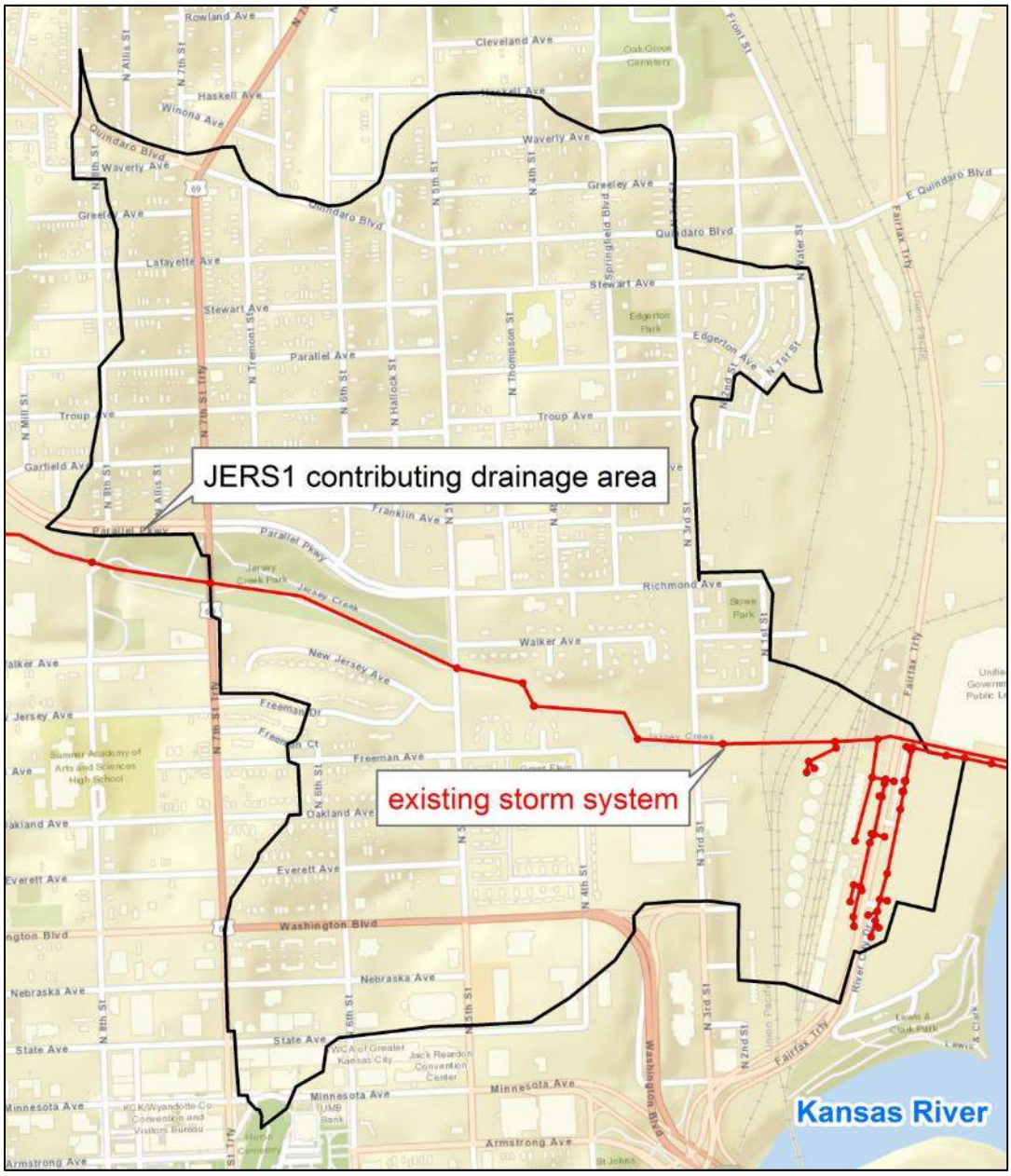

Figure E-19. JERS-1 Existing Stormwater Network.

Proposed Solution

To convey the 5-year, 24-hour storm event and alleviate flooding along Fairfax Trafficway, additional inlet and conveyance capacity is required. Proposed pipe capacity is shown in Figure E-20Figure . An additional 24 inlets would be required on the western portion of the system.

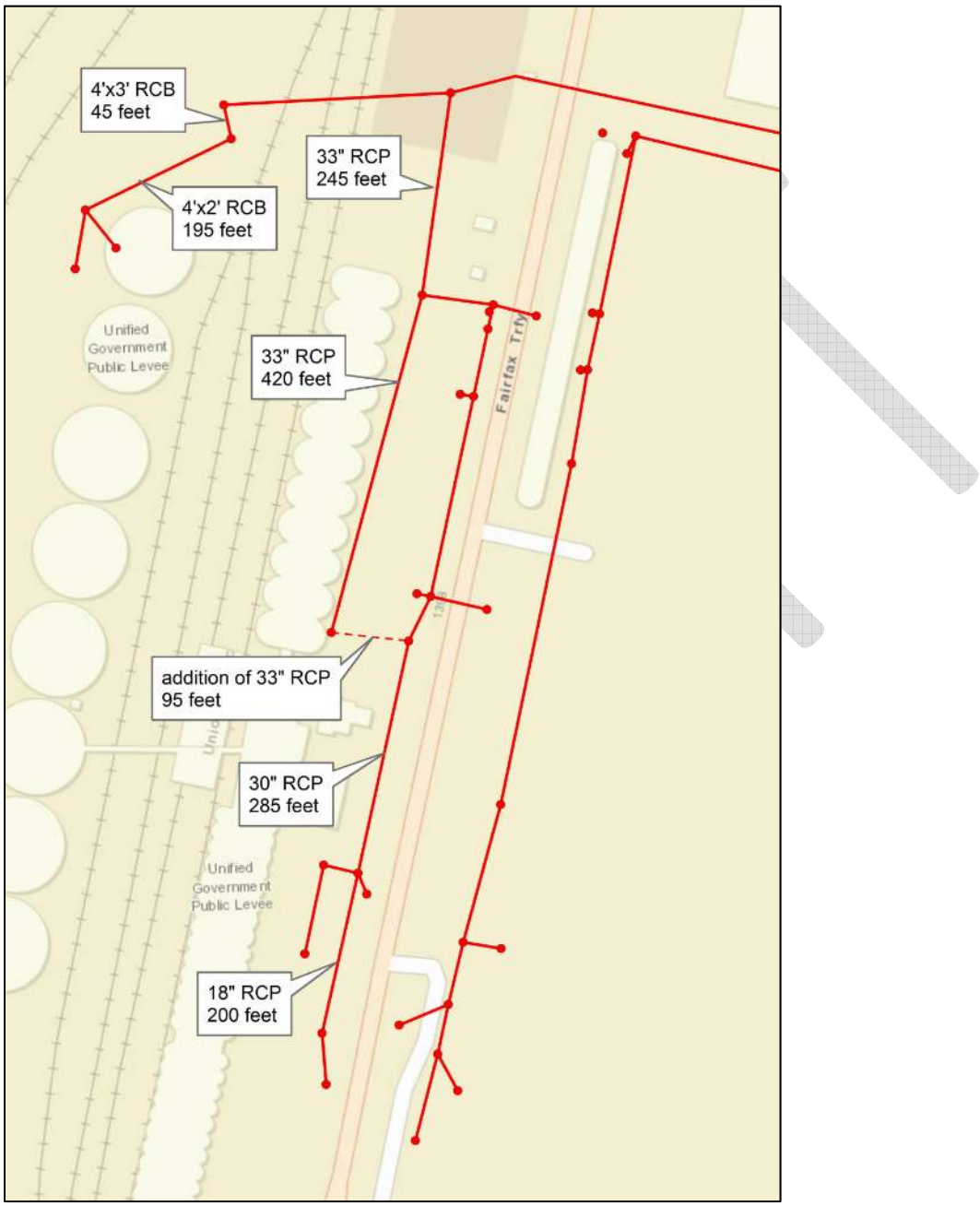

Figure E-20. JERS-1 Proposed Stormwater Network Upsizing for 5-Year Event.

JERS-2

This site is located upstream and south of the JERS-1 project area, shown in the figure below. The project area extends across industrial, residential, and commercial zoning.

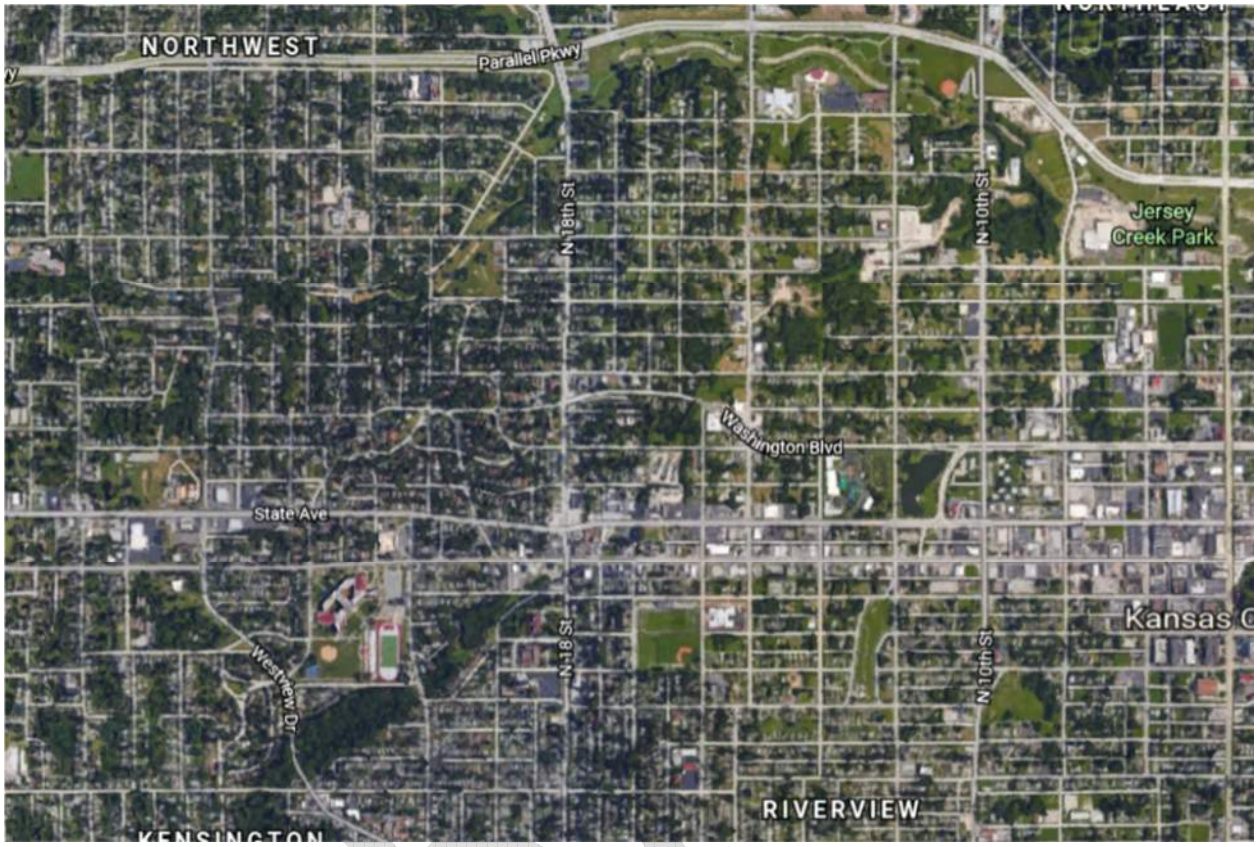

Figure E-21. JERS-2 Project Location

Existing Condition

Roadway flooding has been documented between 9th Street and Armstrong Avenue, including the intersection of 19th Street and Minnesota Avenue, Washington Boulevard and 13th Street, and Washington Boulevard and 15th Street. This site overlaps a recommended project area in the Integrated Overflow Control Plan, with the existing combined sewer system discharging to Jersey Creek and causing water quality issues. Conceptual modeling confirmed a lack of pipe conveyance and inlet capacity throughout the project area.

Proposed Solution

To capture and convey the 5-year, 24-hour storm event below ground and to alleviate roadway flooding in the project area, new stormwater pipe and inlet capacity is required, as shown in the figures below. The proposed improvements assume that the stormwater systems located upstream of the project have adequate capacity to capture and convey the 5-year, 24-hour event to the upstream end of these improvements. Additional inlet capacity will be necessary to convey storm flows to the new pipe system near the intersections previously noted, as well as Nebraska Avenue and Oakland Avenue. This project

site may be divided into multiple projects and coordinated with Integrated Overflow Control Plan projects.

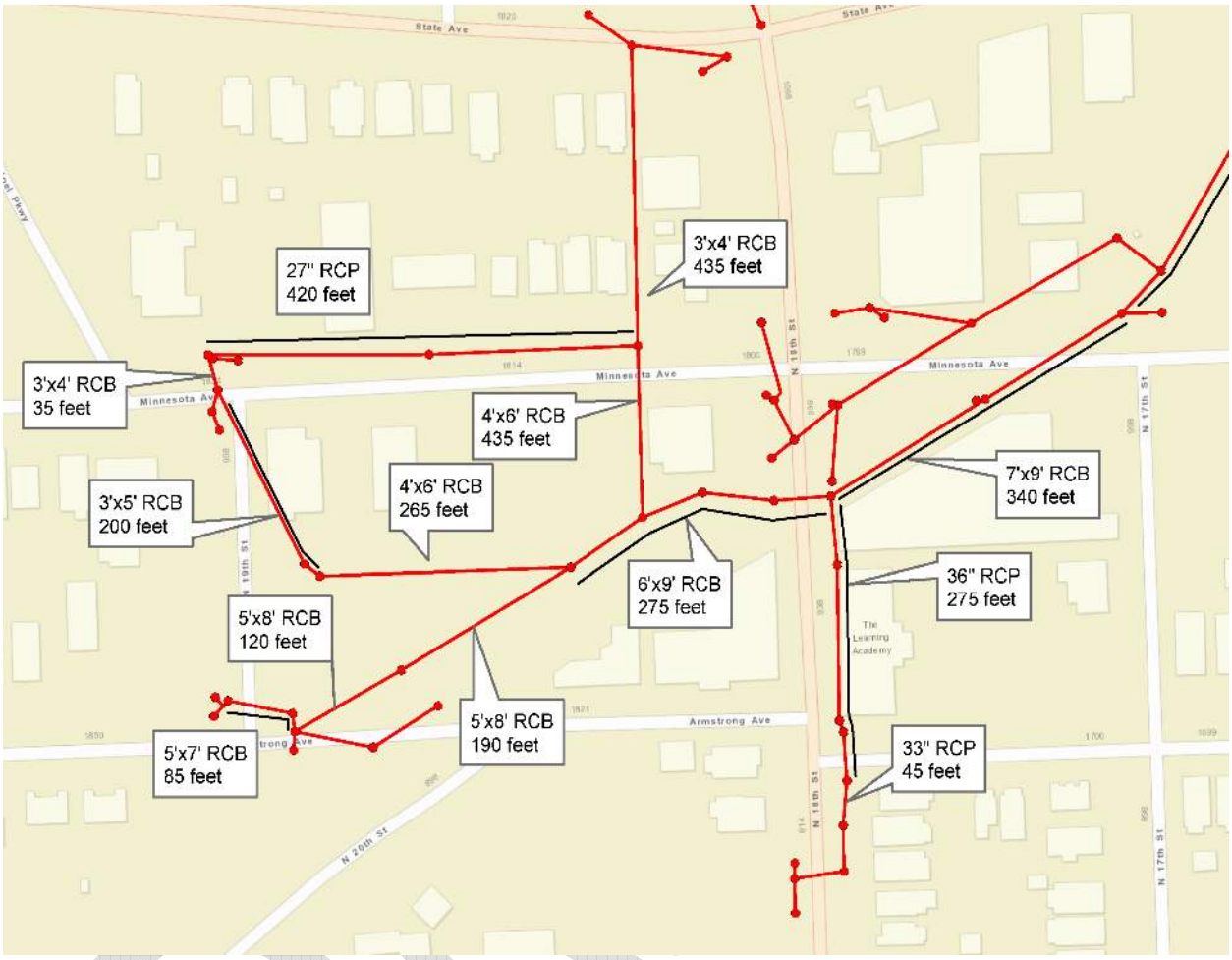

Figure E-22. Proposed Improvements in the upstream portion of JERS 2.

Figure E-23. Proposed Improvements to JERS 2 central conduit.

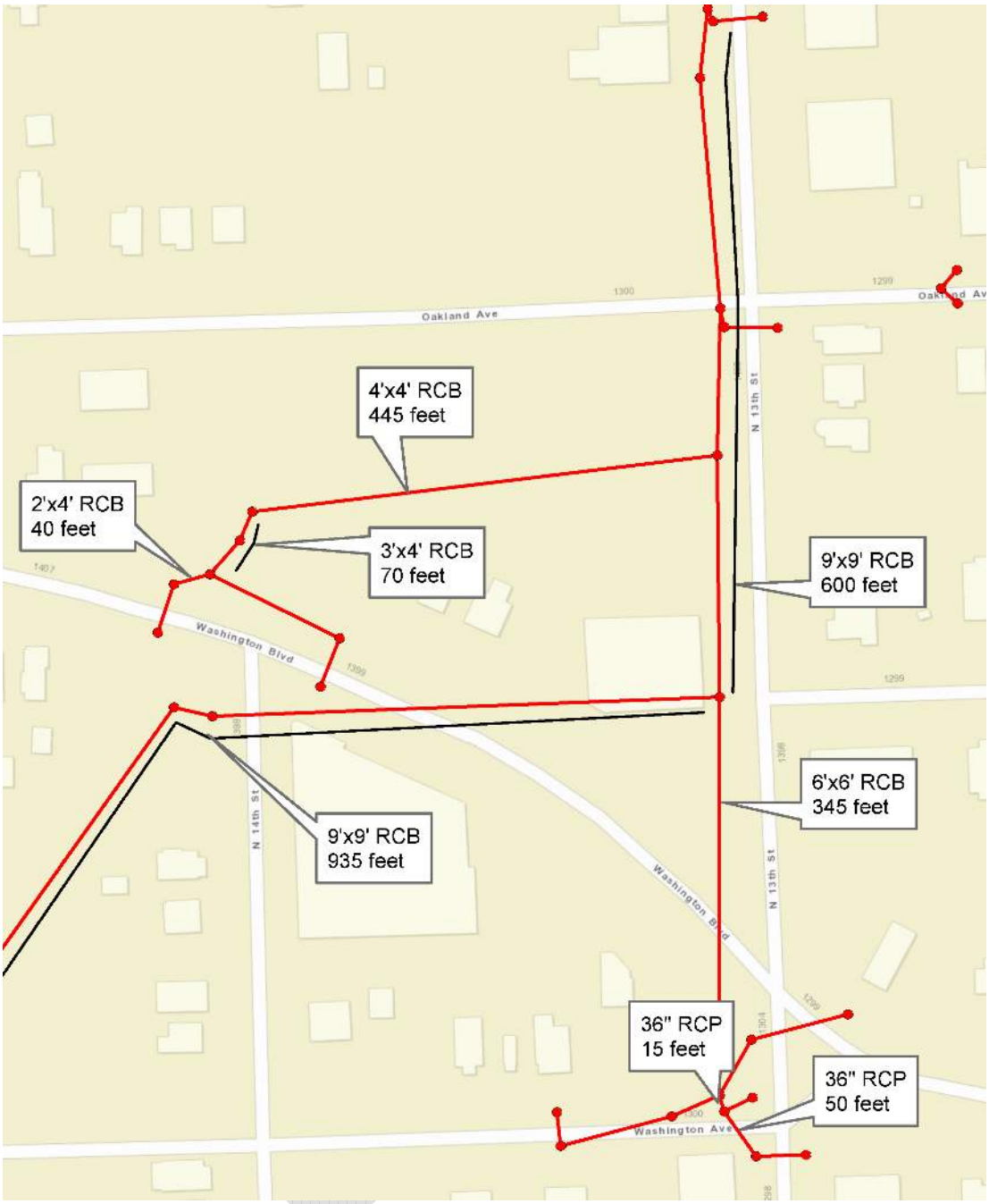

Figure E-24. Proposed Improvements to JERS 2.

Figure E-25. Proposed Improvements to JERS 2 central conduit.

Figure E-26. Proposed Improvements to JERS 2 tie-in to JERS 3.

During preliminary design, a more refined analysis of this area may reveal that detention storage can be implemented to reduce the need for additional pipe and inlet capacity. The figures below demonstrate the extent of Land Bank and vacant property in the project area that may be considered for detention storage.

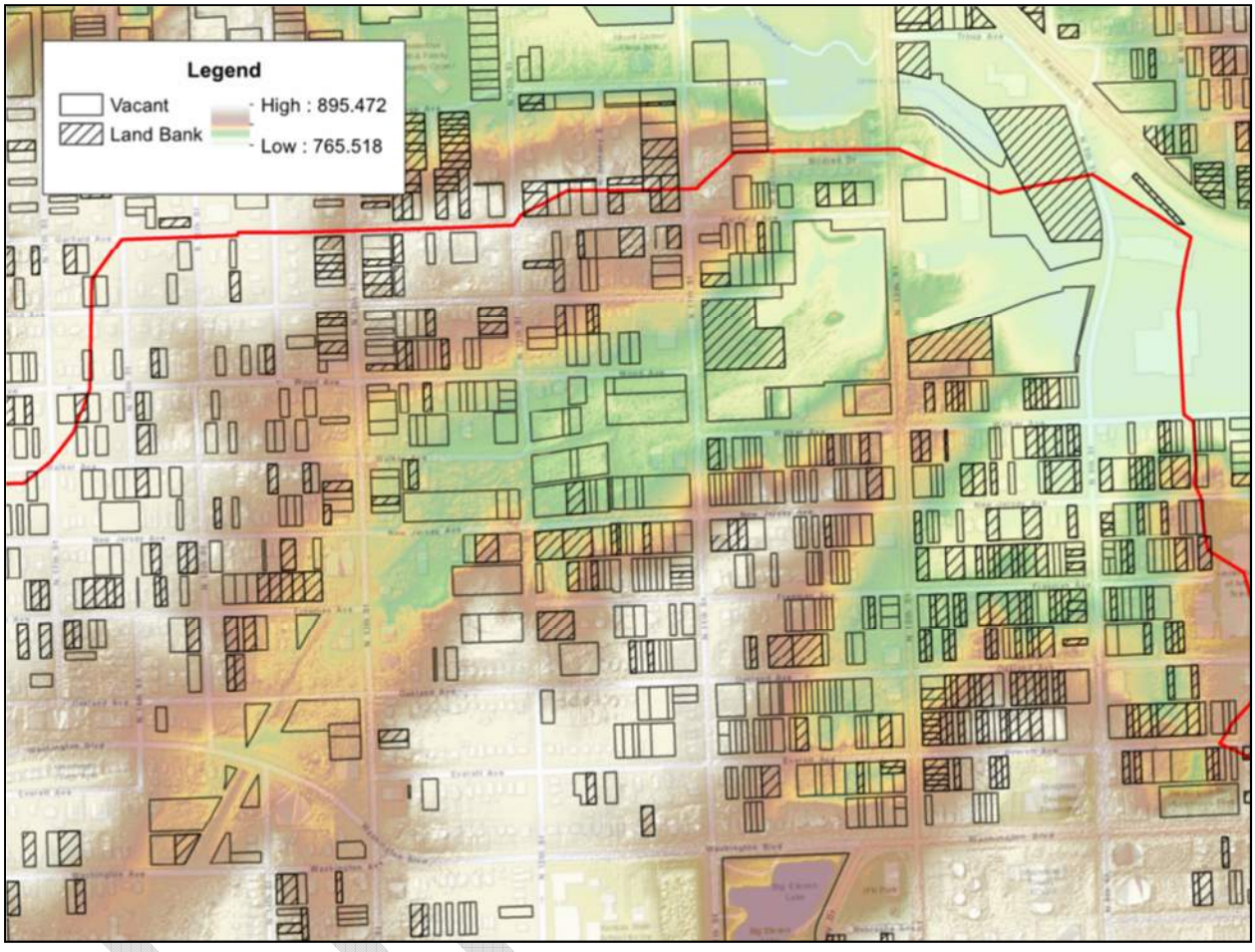

Figure E-27. Vacant and Land Bank Properties in JERS-2 Project Area, Northern

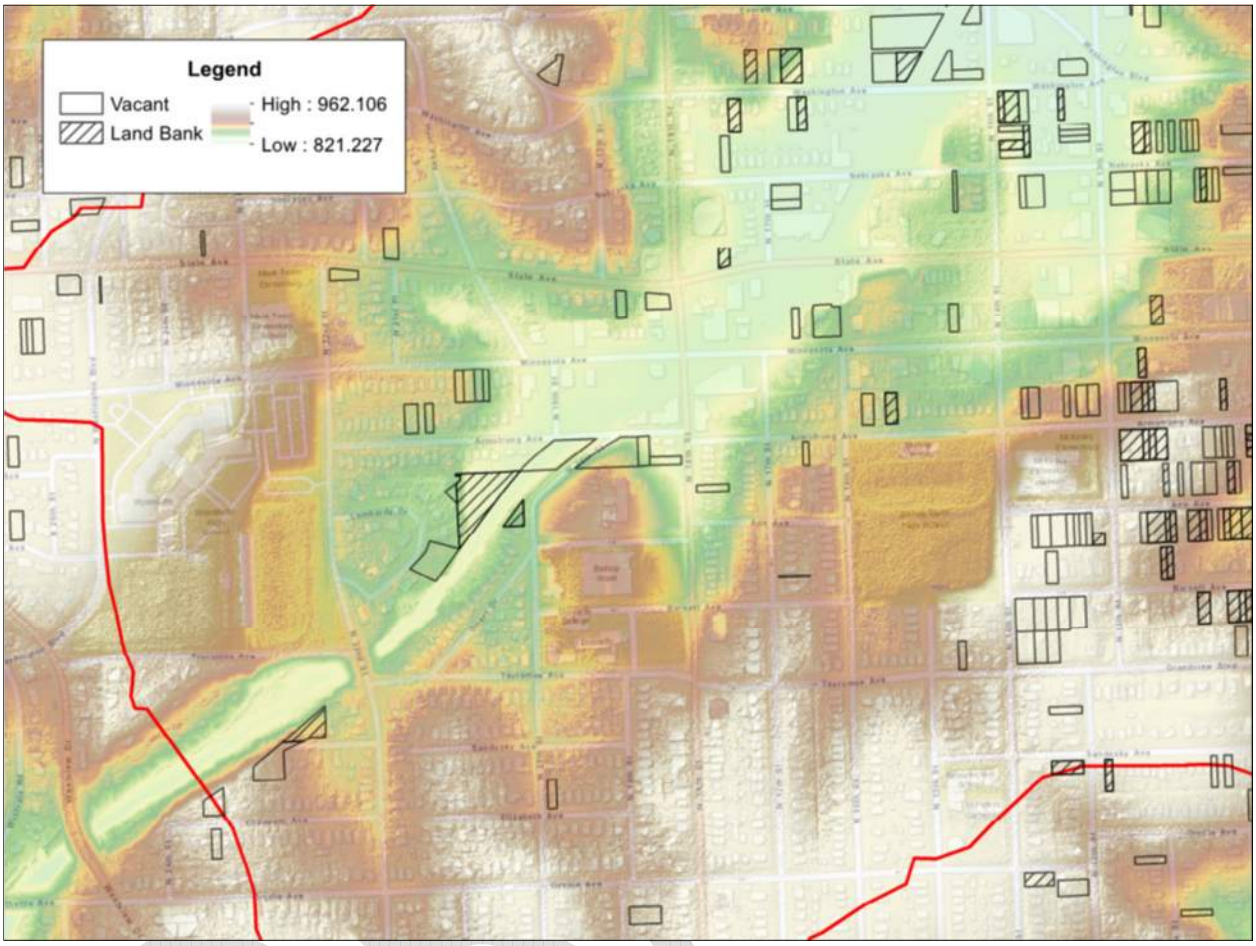

Figure E-28. Vacant and Land Bank Properties in JERS-2 Project Area, Southern.

JERS-3

This site includes a reach of Jersey Creek located in Jersey Creek Park, extending nearly 4,000 linear feet south of Parallel Parkway, bounded by North 18th Street on the west and North 10th Street on the east. This reach includes a concrete-lined trapezoidal channel and is bounded at the downstream end by the JERS-2 project. The area is mixed-use, but primarily residential with some park land.

Figure E-29. Aerial view of Jersey Creek, which runs adjacent to Parallel Parkway from west to east.

Existing Condition

During the 5-year event, conservative peak flow estimates range from 4,100 cubic feet per second (cfs) in the upstream end to 6,400 cfs at the downstream end. At peak flow in Jersey Creek, the contributing stormwater drainage network surcharges within the park. Although no specific flooding issues were documented for this area, the model shows localized flooding in the park and overland flow in the contributing system.

Proposed Solution

Based on discussion with the UG and review of area plans, the proposed solution includes restoring the concrete-lined channel to a stabilized natural channel. An initial concept was developed to establish a cost estimate for the proposed improvement. This concept is based on development of a stable natural channel, sized to convey the 2-year peak discharge, the channel forming flow. Flood benches were integrated to ensure that the 5-year peak discharge is contained within the channel. Downstream project improvements at JERS-2 may impact the proposed design of this area.

LTTN-2

Site LTTN-2 is located directly north of I-70 near the source of the Little Turkey Tributary. This tributary is located east of N 86th Street and flows under I-70 toward the Kansas River. Figure E-30 presents the area of interest.

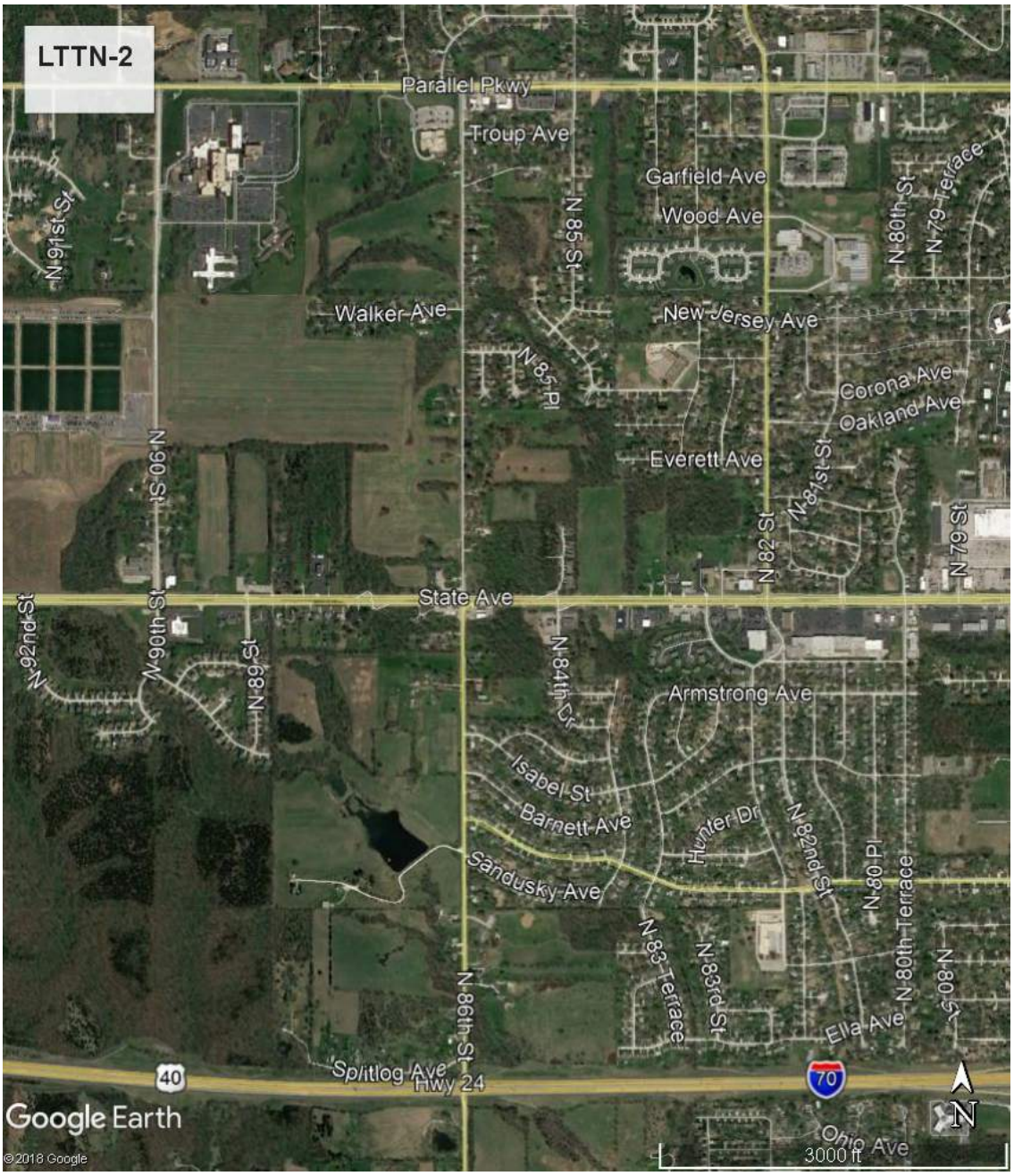

Figure E-30. LTTN-2 Project Location

Existing Condition

Modeling confirmed reported flooding at the I-70 culvert during the 5-year, 24-hour event. Reports documented structural flooding along 83rd Terrace between Isabel Avenue and Ella Avenue. The area of flooding documented in the modeling showed impact to five properties, located south of Ella Avenue. A concrete channel conveys the bulk of the flow from the area to the south; surveyed conditions showed significant damage to the concrete lining, the extent of which is shown in Figure E-31.

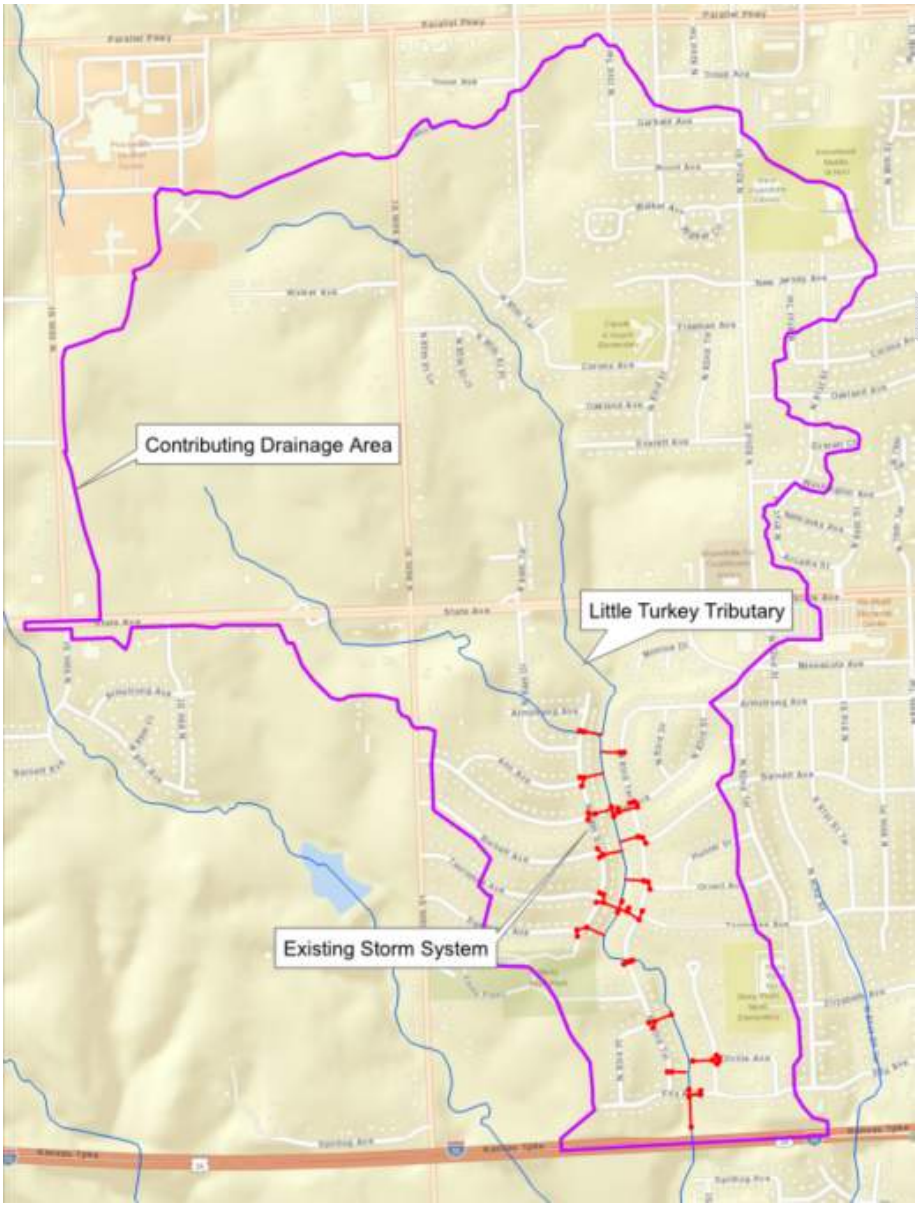

Figure E-31. LTTN-2 Existing Stormwater Network.

The modeled extent of inundation from the 5-year, 24-hour event is presented in Figure E-32. One parcel on the west side of the channel and four parcels east of the channel are impacted.

Figure E-32. LTTN-2 Concrete-Lined Portion of Little Turkey Tributary

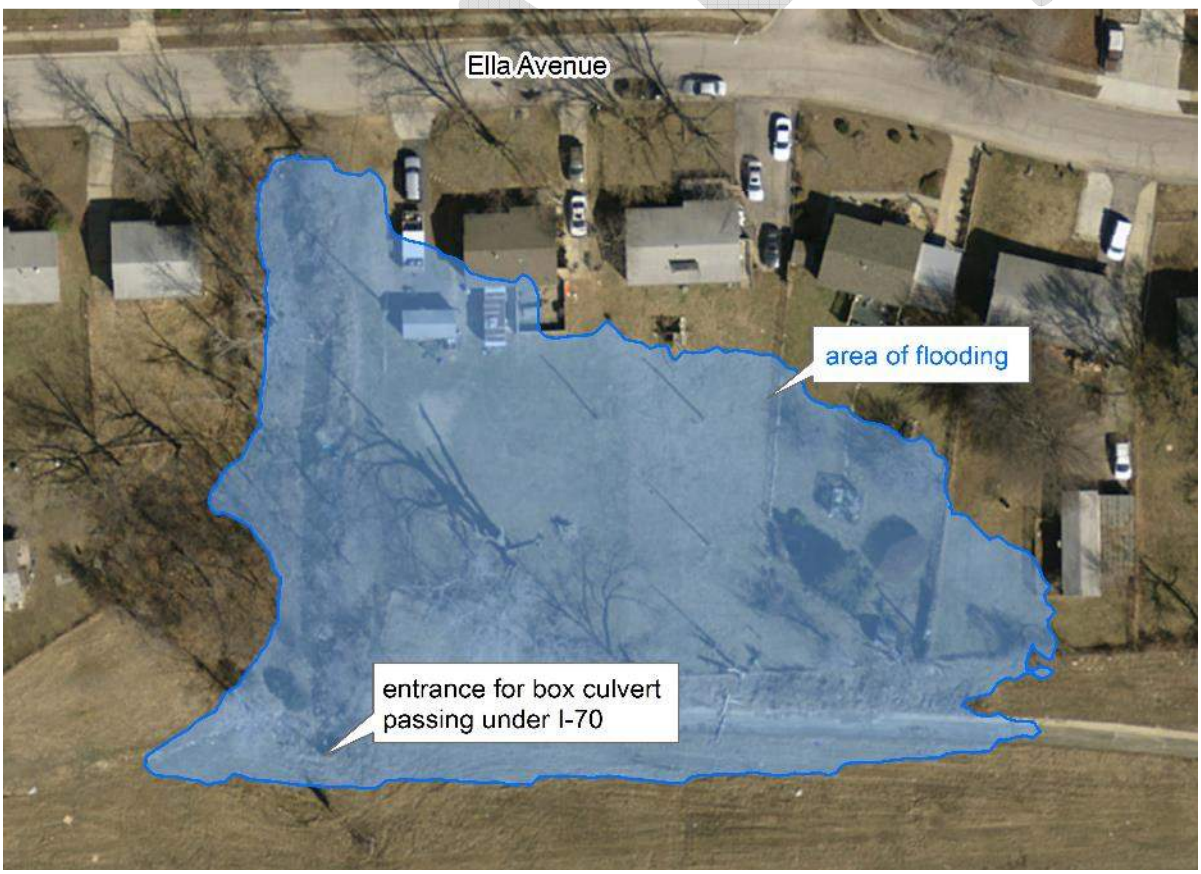

Figure E-33. LTTN-2 Area of Existing Flooding for 5-Year Storm Event

Proposed Solution

There are several options to address flooding in this area. In the Concept Design Workshop on June 19, 2018, the UG noted that the I-70 culvert was not sized correctly, and the preferred option would be to buy some properties and provide stormwater detention. The proposed solution for this site includes purchase of the parcels adjacent to the stream channel and development of a detention facility that provides approximately 2.9 acre-ft of storage. The proposed area of the detention facility is 23,000 square feet. The maximum depth of the facility was assumed to be 6 feet. Additionally, the concrete-lined channel is proposed to be returned to an engineered natural channel to reduce cost of operation and maintenance.

Figure E-34. LTTN-2 Area of Proposed Detention.

Figure E-35. The concrete-lined channel spans LTTN-2 from north to south in varying states of disrepair.

MILL-3

Site MILL-3 is located north and south of Parallel Parkway. Stormwater drains east to Mill Creek located directly south of intersection Greeley Avenue and N 81st Street.

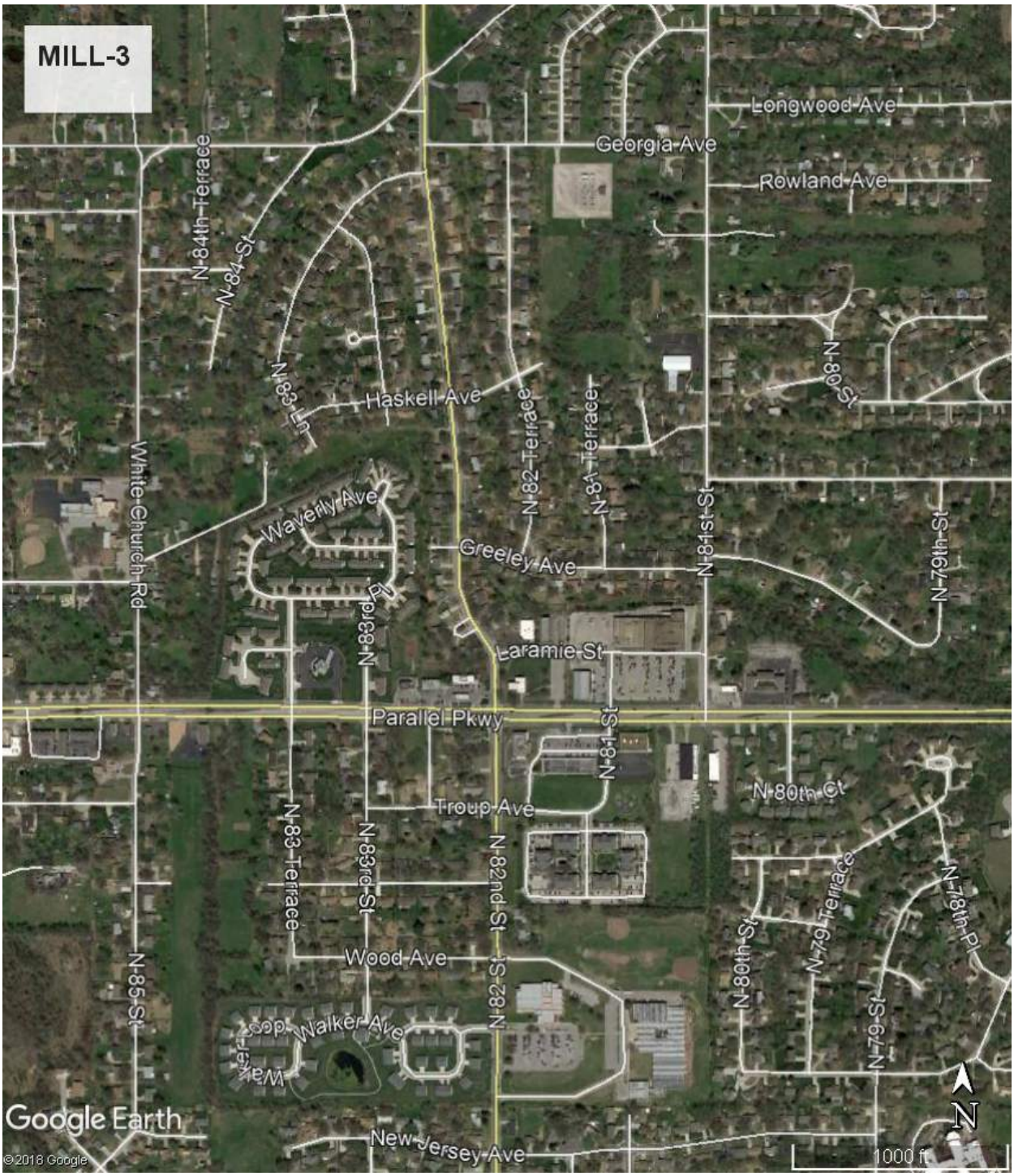

Figure E-36. MILL-3 Project Location.

Existing Condition

Reports documented roadway and yard flooding along 82nd Terrace between Haskell Avenue and Greeley Avenue, and along Greeley Avenue between 82nd Terrace and 81st Street. Figure E-37 shows the existing storm system and contributing watershed which contains an inadequately sized and discontinuous storm sewer system resulting in street and yard flooding. The total drainage area is approximately 168 acres.

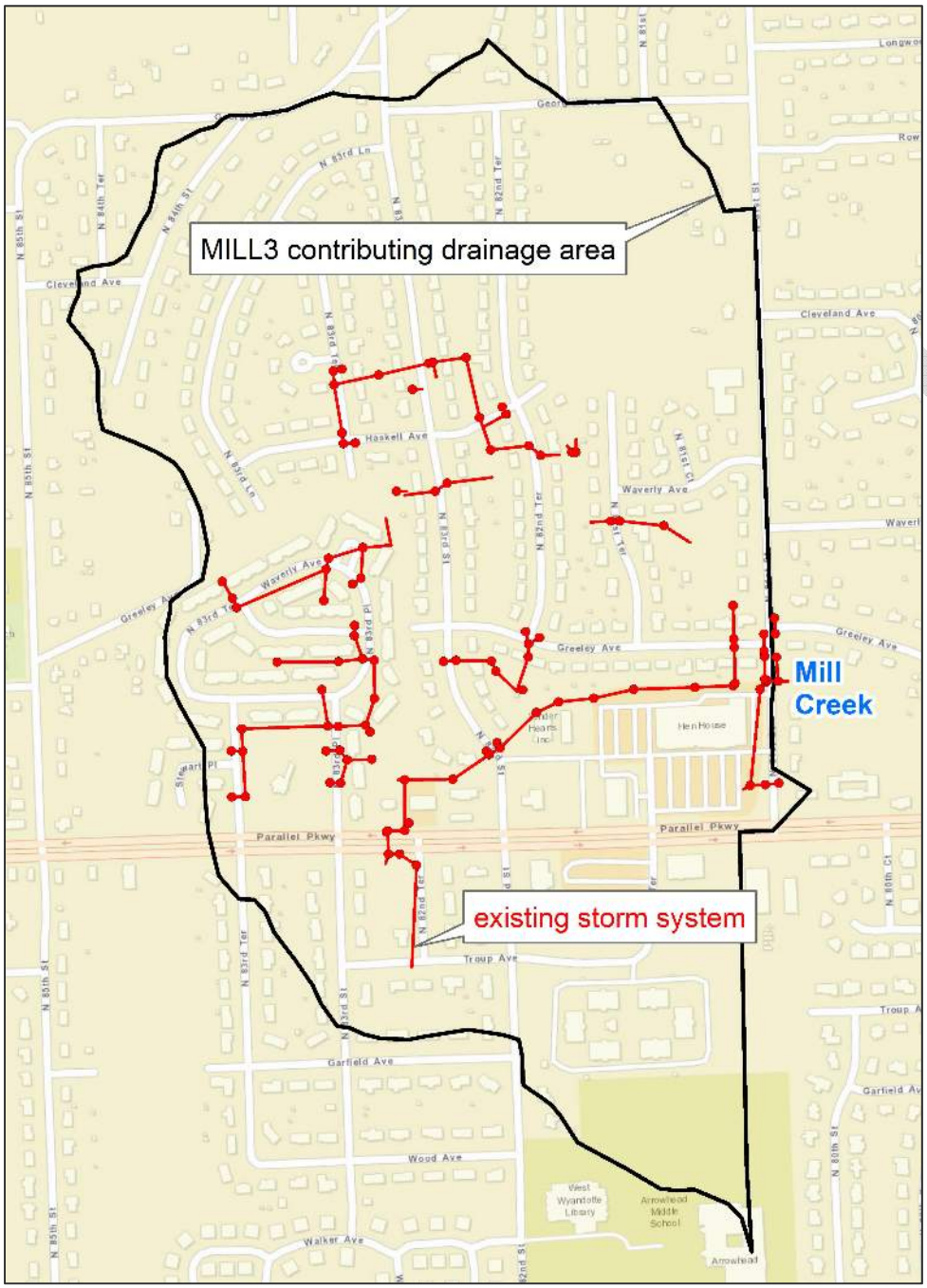

Figure E-37. MILL-3 Existing Stormwater Network.

Proposed Solution

To convey the 5-year, 24-hour storm event, increased pipe capacity was modeled. Proposed pipe infrastructure is shown in Figure E-38. B&V recommends the use of reinforced concrete pipe (RCP) however, high density polyethylene (HDPE) pipe has been assumed in the proposed solution, reflecting the UG's preference. Additional inlet capacity will be required along these new pipe systems. Assuming an inlet capacity of 5 cfs/inlet, a total of 24 new inlets are proposed. Finally, the replacement of open channel with reinforced concrete box culvert is proposed to maintain an underground conveyance of the 5-year event.

Figure E-38. MILL-3 Proposed Stormwater Network Upsizing for 5-Year Event.

MILL-5

The MILL-5 site is located along Georgia Avenue, bounded on the west by N 75th Terrace and on the east by North 73rd Street. The general area is presented in Figure E-39.

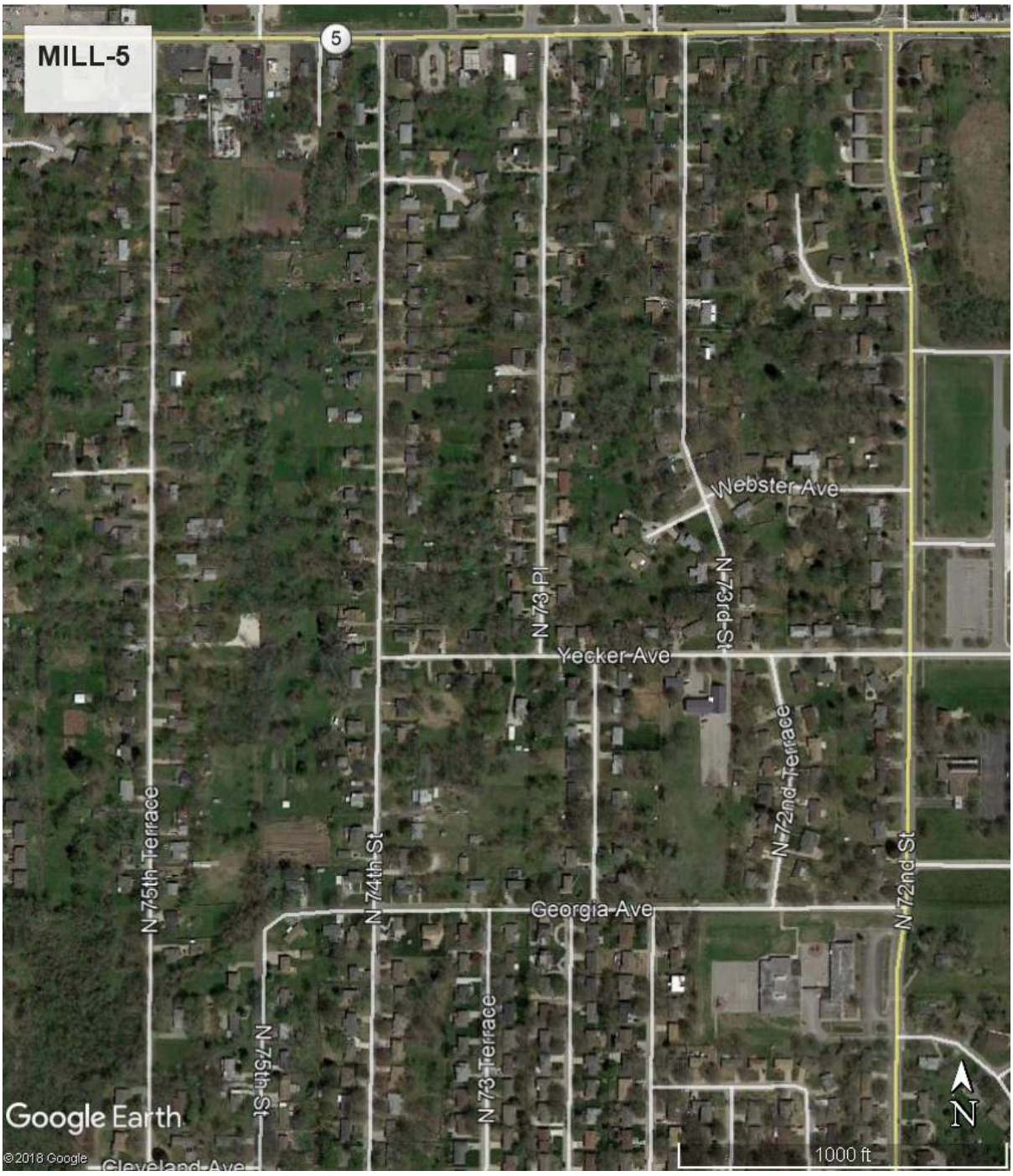

Figure E-39. MILL-5 Project Location

Existing Condition

Existing records document roadway and property flooding at 73rd Terrace and Georgia Avenue. The existing pipe under 73rd Place does not have sufficient capacity. Additionally, the UG noted the poor condition of the pipe that drains this subarea, passing under N 75th Terrace and conveying flow to Mill Creek. The total drainage area is approximately 126 acres.

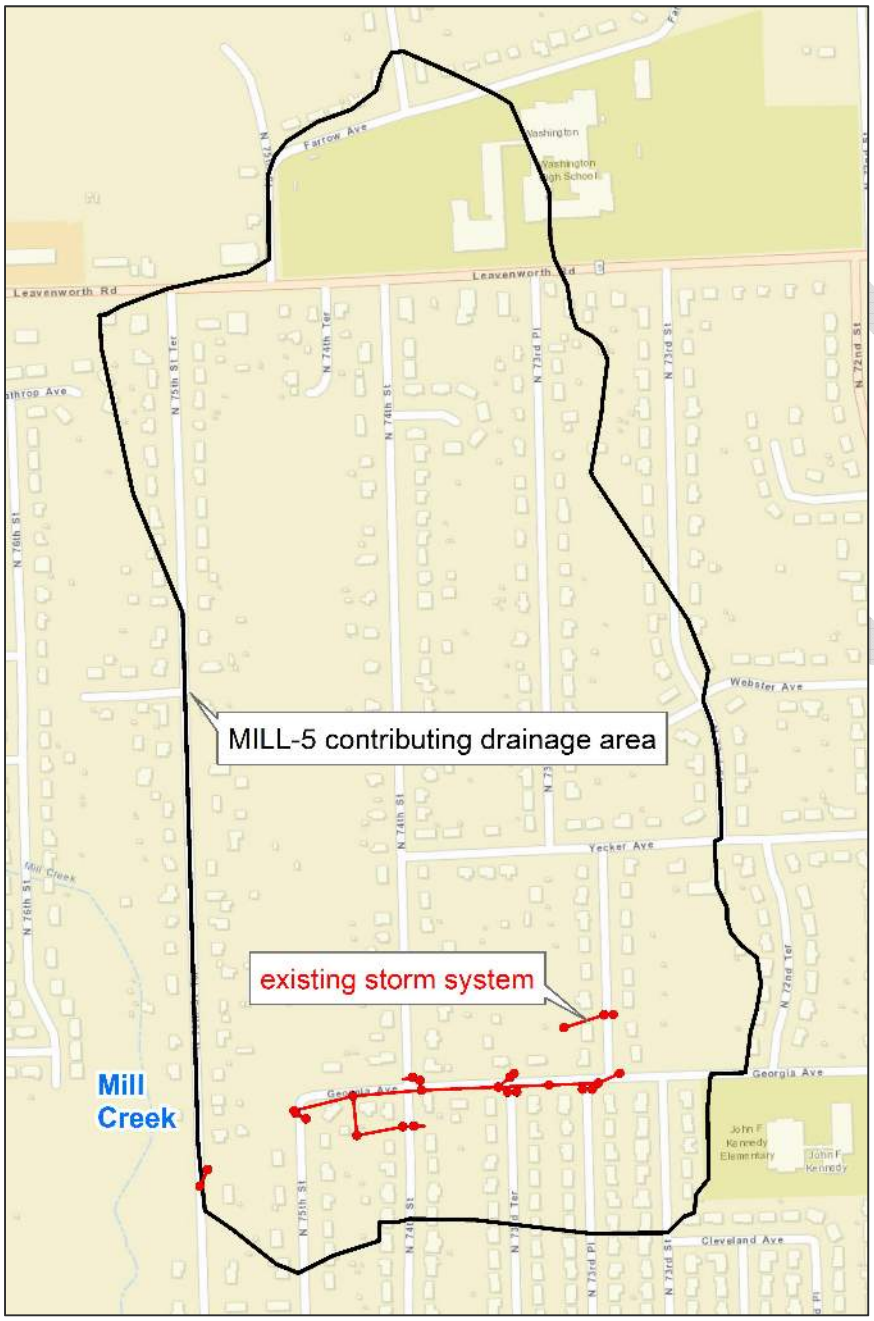

Figure E-40. MILL-5 Existing Stormwater Network.

Proposed Solution

The proposed solution includes replacement of pipe, as shown in Figure E-41, to convey the 5-year, 24-hour event. HDPE pipe is assumed to convey flow and provide system connectivity through residential yards. Overland flow paths will be necessary to ensure conveyance of larger storm events. Additional inlet capacity is also required; a total of 3 new inlets are proposed for this site.

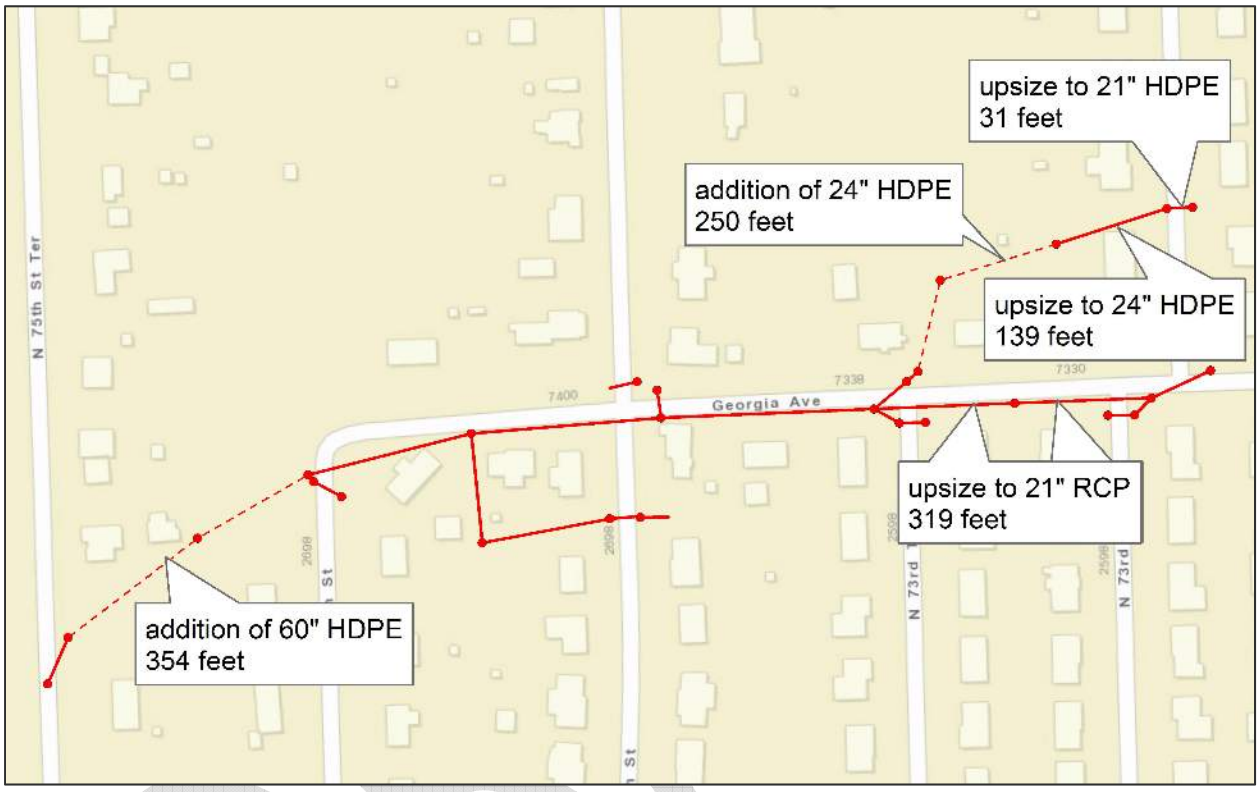

Figure E-41. MILL-5 Proposed Stormwater Network Upsizing for 5-Year Event.

MILL-6

Site MILL-6 is located along Yecker Avenue and is bordered by N 74th Street and N 73rd Street. This area is presented in Figure E-42.

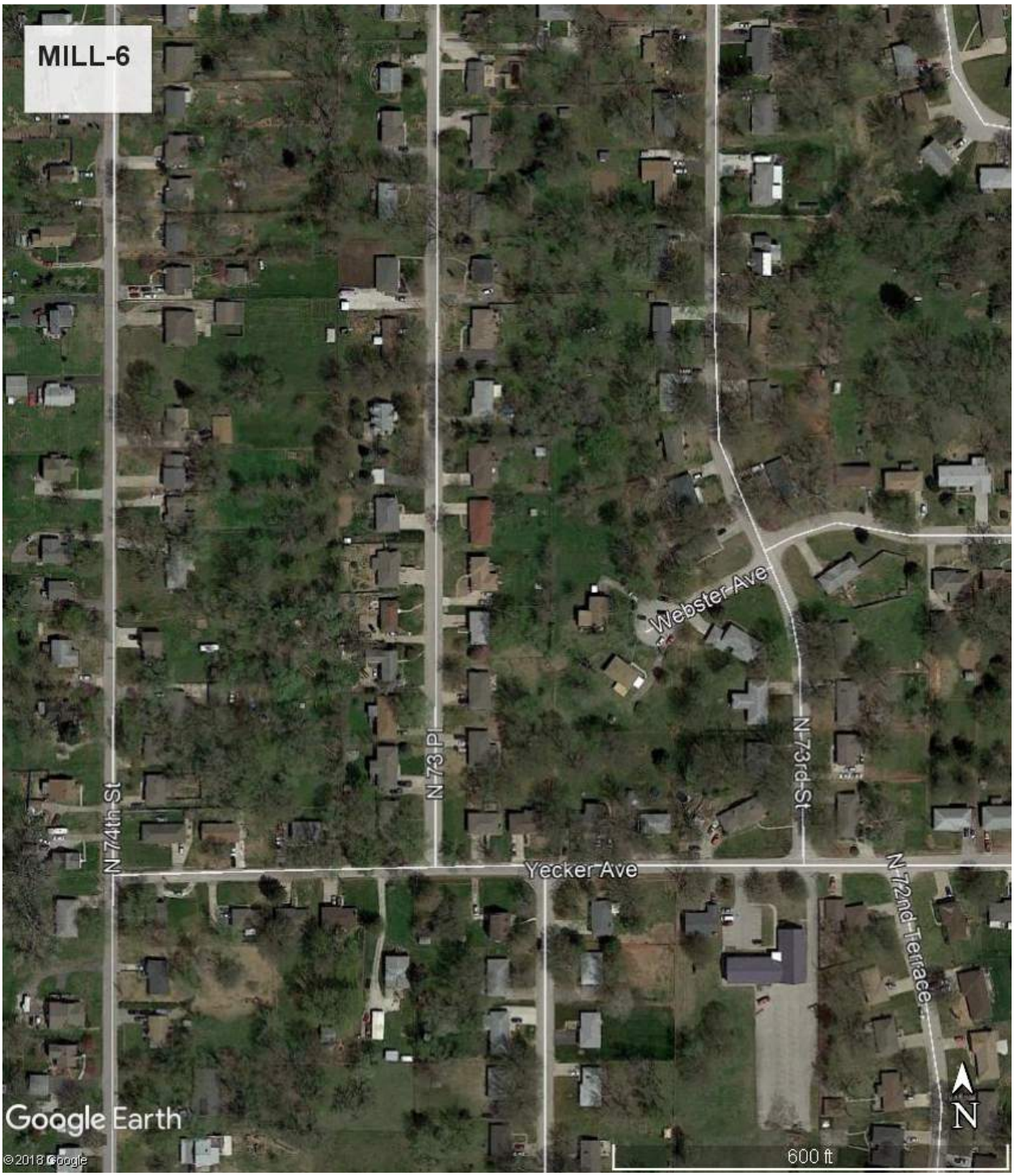

Figure E-42. MILL-6 Project Location.

Existing Condition

The MILL-6 site conveys stormwater from a small watershed of roughly 20 acres. The existing stormwater network is minimal and consists of corrugated metal pipe (CMP). Flooding has been documented near N 74th Street and Yecker Avenue. At this intersection, two CMP culverts drain west towards Mill Creek. Draft modeling indicates flooding at the upstream end of both culverts. The northern culvert is sized at 18" and the southern culvert is 15". Stormwater conveyed through these pipes flows into an open ditch that slows flow before entering another pipe section. Accumulation of debris was noted at these culverts during the survey, as shown in Figure , and may also be contributing to flooding issues.

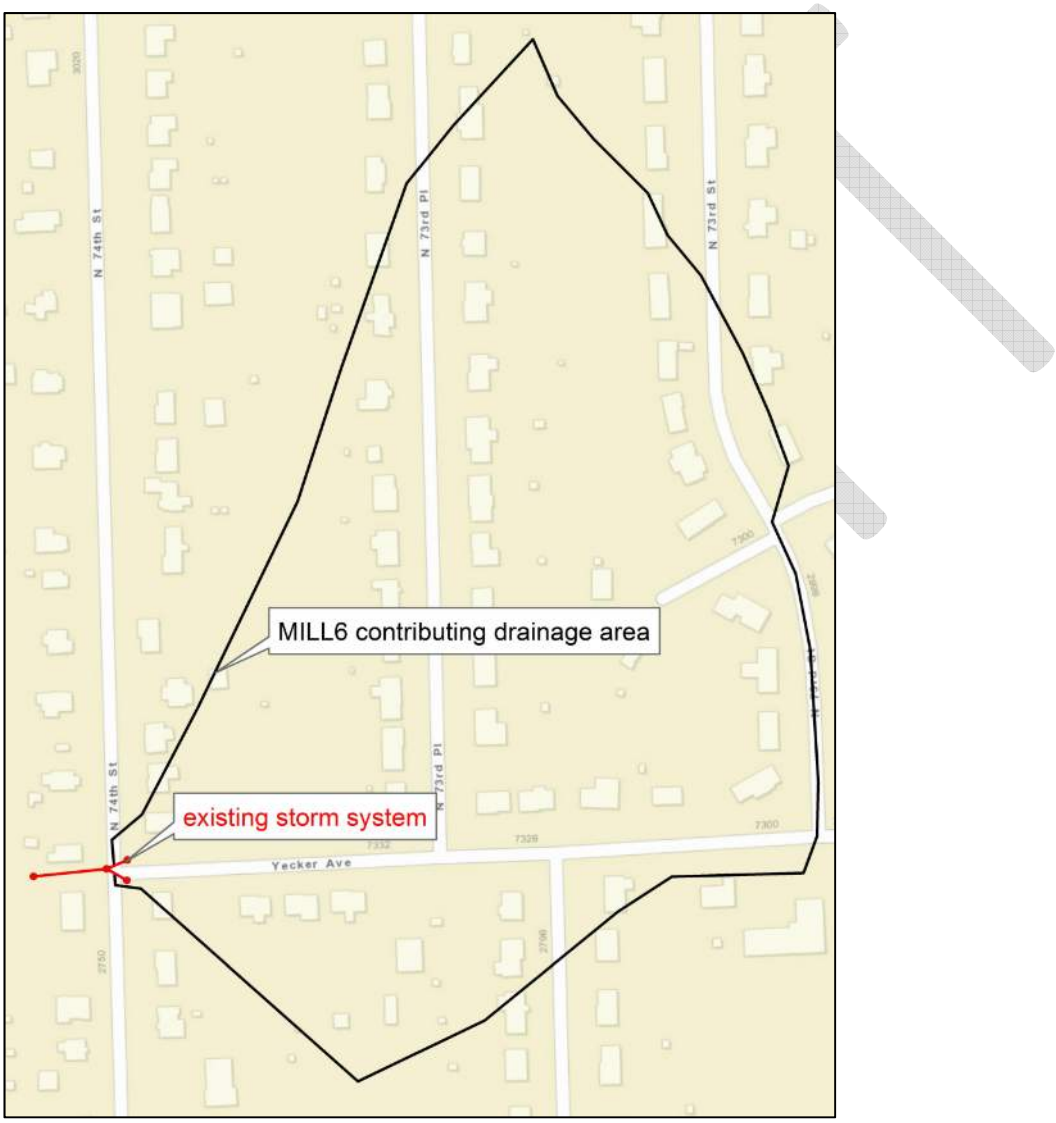

Figure E-43. MILL-6 Existing Stormwater Network.

Figure E-44. Surveyed condition of CMP Culvert at N 74th Street and Yecker Avenue.

Proposed Solution

The proposed solution includes replacement of existing pipe with larger capacity, as shown in Figure E-45. Additional HDPE pipe is integrated to provide drainage along Yecker Avenue. A naturalized channel could be considered as an alternate. Limited regrading is associated with the addition of any new pipe to ensure drainage. Additional inlet capacity is also required; a total of 4 new inlets are proposed for this site.

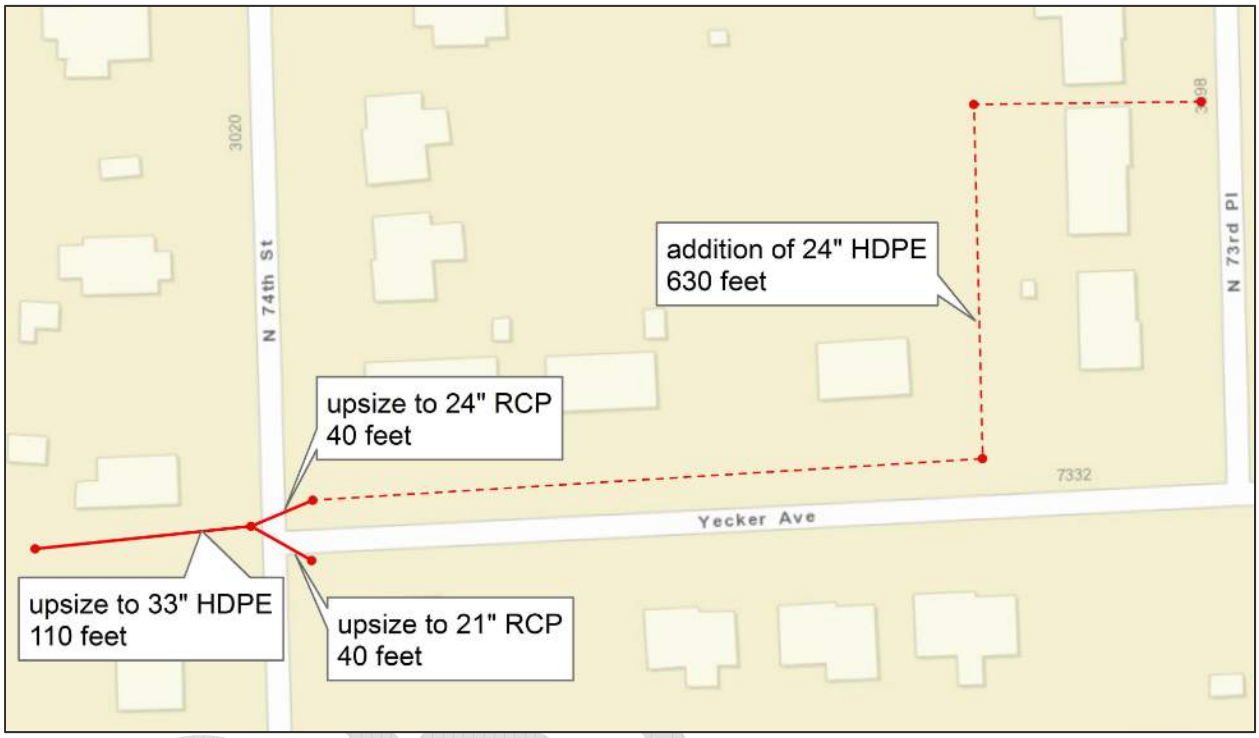

Figure E-45. MILL-6 Proposed Stormwater Network Upsizing for 5-Year Event.

MUNC-1

Site MUNC-1 is located south of the Kaw Valley Scenic Highway and west of the Kansas River, as shown in Figure E-46.

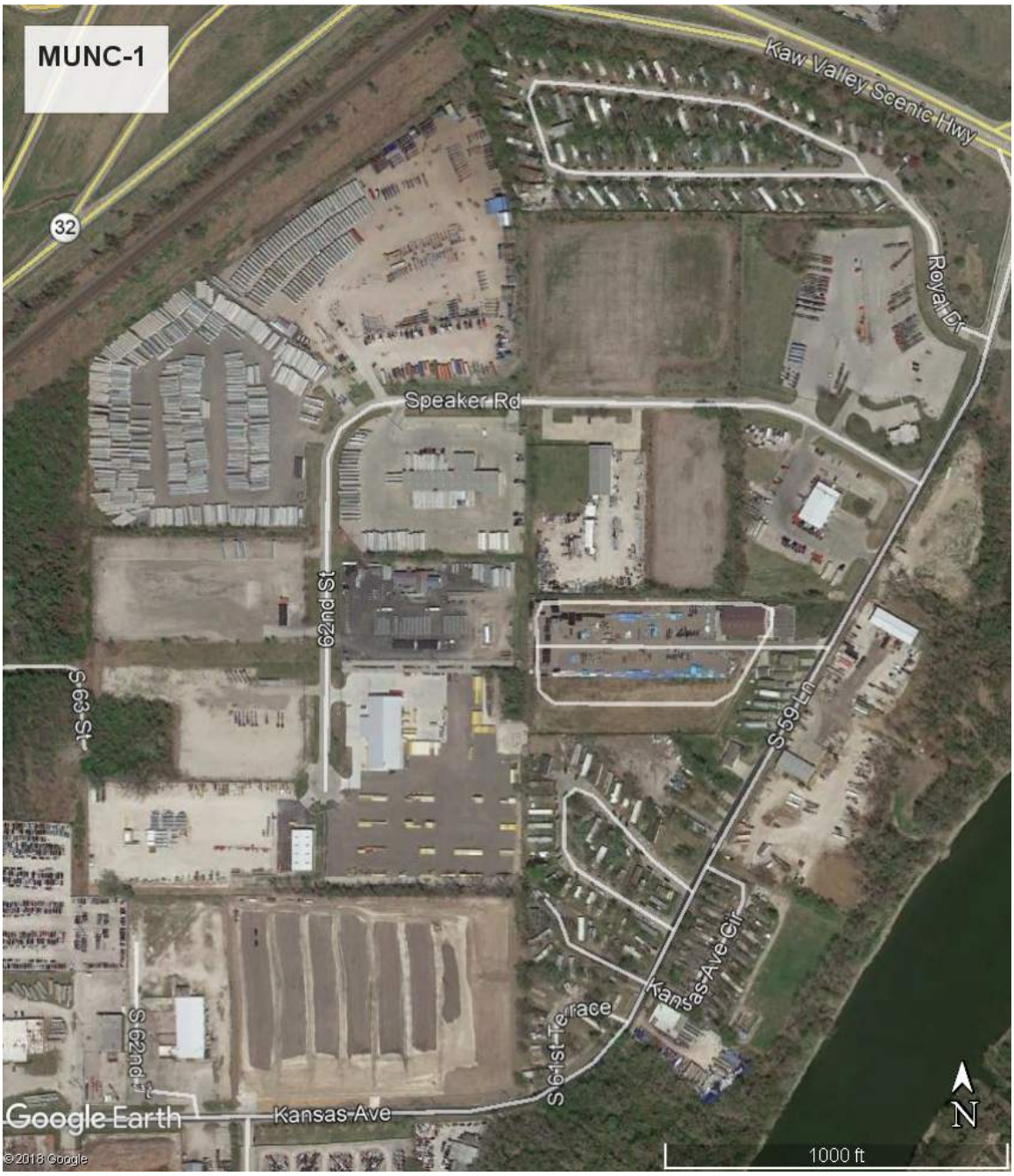

Figure E-46. MUNC-1 Project Location.

Existing Condition

The MUNC-1 site conveys stormwater from an industrial area to the Kansas River. The existing stormwater network, shown in Figure E-47, includes multiple outfalls to the river. Drainage issues have been reported along Speaker Road, Royal Drive, and South 59th Lane. Survey was completed to identify pipes missing in the GIS network and to document condition of the existing system.

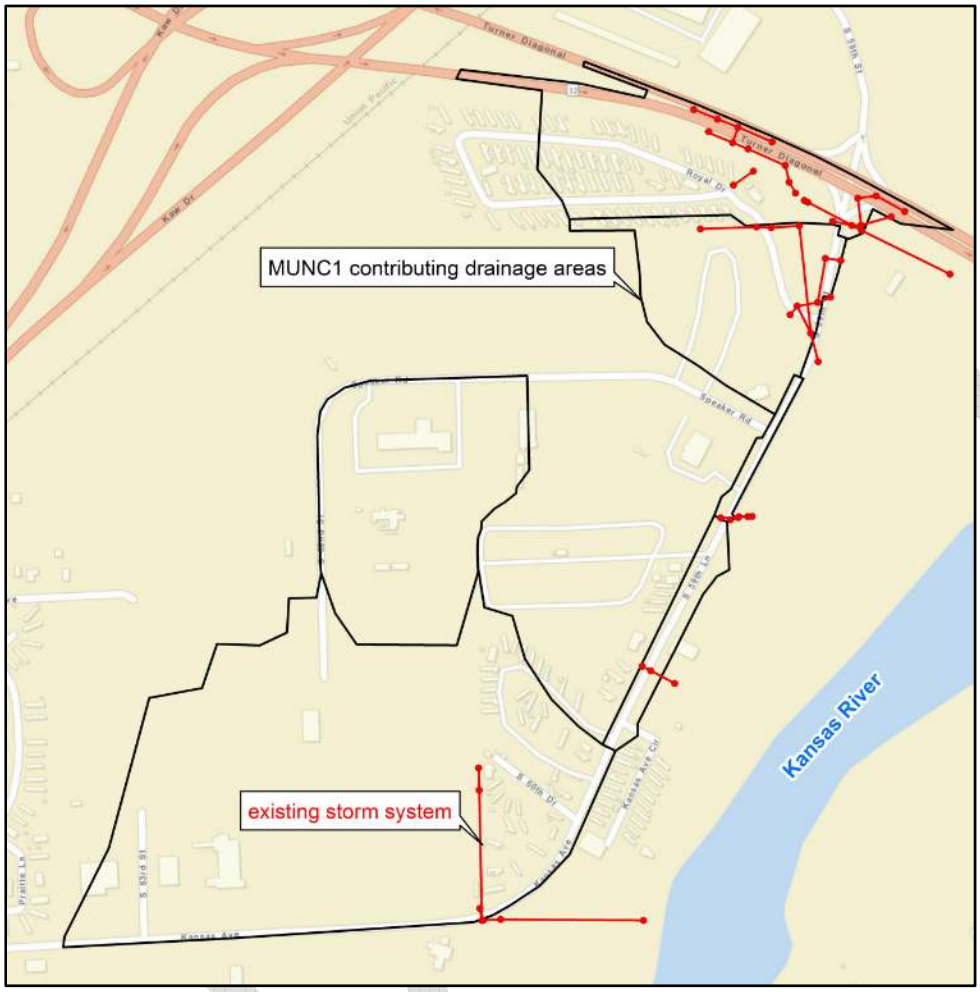

Figure E-47. MUNC-1 Existing Stormwater Network.

Draft modeling of the existing stormwater network indicates that significant flooding losses occur at an unidentified structure upstream of manhole 220-509-MH. Figure E-48 provides the location of this section of the network. The estimated contributing drainage area to the unidentified structure is 41 acres. The main network upstream and downstream of the structure is 48" RCP.

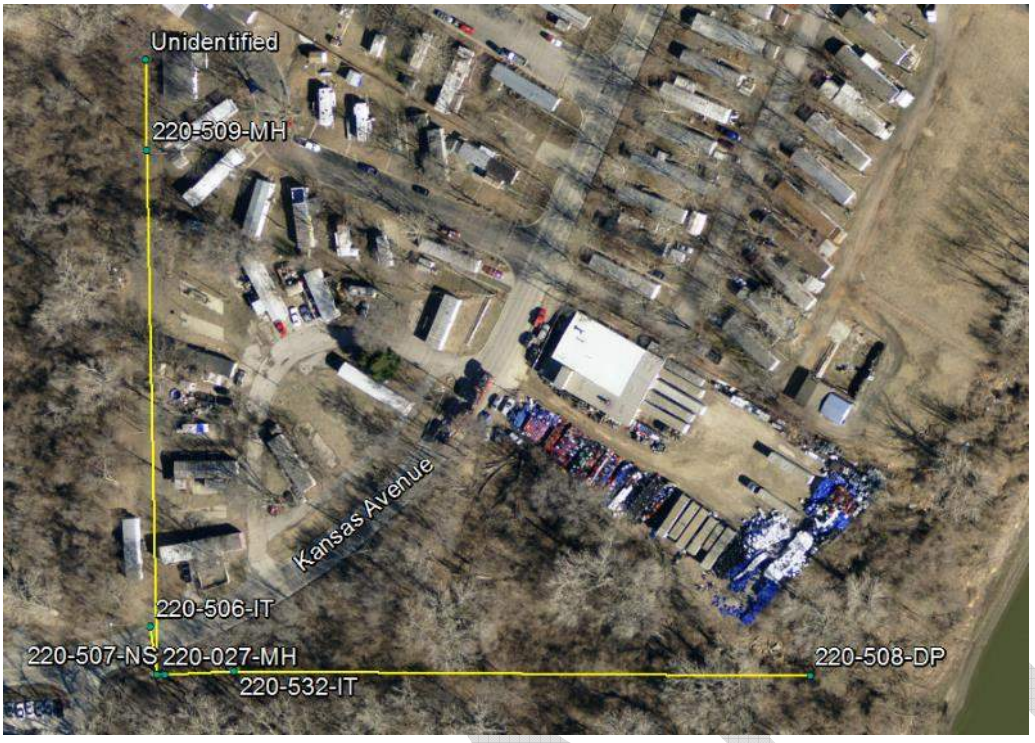

Figure E-48. MUNC-1 Location of Most Significant Flooding, Upstream of Structure 220-509-MH.

Survey of the site indicated that the downstream outfall of this section has been compromised. The UG discharge point 220-508-DP is within proximity to the Kansas River and has been disconnected due to the effects of rising water conditions. The figure below demonstrates the failed condition of the outfall.

Figure E-49. Failed outlet structure in MUNC-1 watershed.

Additional drainage issues have been reported for the commercial area along Speaker Road. Further review of topography and aerial imagery confirmed inadequate drainage in this low-lying depression. A network of storm sewer does not extend to Speaker Road. Rather, a series of swales direct runoff from the road to undeveloped areas of the site.

Google Earth imagery provided in Figure E-50 and E-51 indicate the location of most significant flooding at Speaker Road, with standing water shown during dry weather conditions. Sediment deposits appear to have impacted the conveyance capacity of the swale. Grading at this location may also not be sufficient for proper drainage of the road.

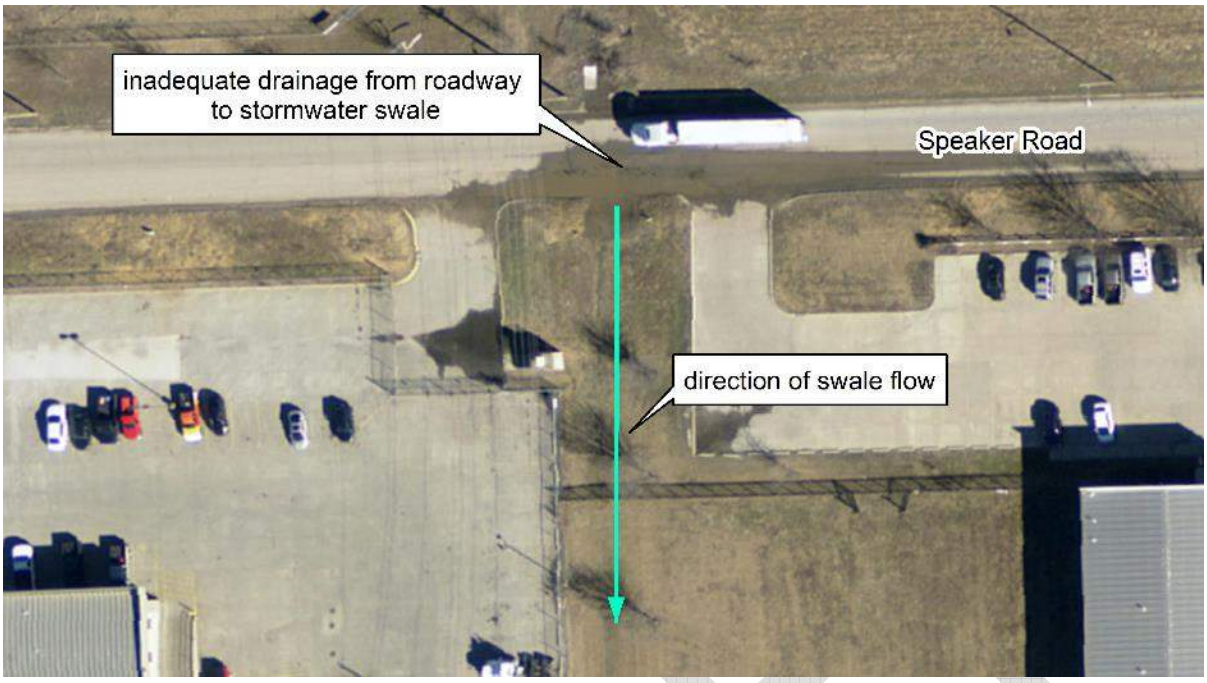

Figure E-50. Aerial of Inadequate Drainage Along Speaker Road (Google Earth)

Figure E-51. Sediment Deposition Affecting Conveyance Capacity of Stormwater Swale along Speaker Road (Google Earth).

Remaining survey of the MUNC-1 site indicated additional failed stormwater structures that should be noted. Within the Royal Mobile Home Park along Royal Drive is UG inlet structure 219-561-IT. This inlet is the only node for drainage of the park and is filled with sediment. An unidentified manhole within proximity of the inlet was shown to be filled with sediment as well. The figures below demonstrate the location and conditions of these structures.

Figure E-52. Location of UG Structure 219-561-IT.

Figure E-53. UG Structure 219-561-IT Filled with Sediment.

Proposed Solution

To be able to convey the 5-year storm event, the proposed solution includes replacement of the outfall, structure 220-509-DP. Additionally, this section will need to be upsized to a maximum pipe diameter of 60-inch RCP. To address the drainage issues along Speaker Road, the proposed solution extends the stormwater network north for a total of 985 feet of 48" RCP. The stormwater swale identified in Figure can continue to convey runoff from Speaker Road provided that sediment deposits are removed and grading further evaluated.

Figure E-54Figure provides a schematic of the network lines to be replaced and added.

Figure E-54. MUNC-1 Proposed Stormwater Network Upsizing for 5-Year Storm Event.

TURK-4

Site TURK-4 is located near the ramps off of Southwest Boulevard onto Mission Road/Interstate I-35. Stormwater drains to Turkey Creek which flows northeast to the Kansas River. The area of interest is presented in Figure E-55. The UG noted at the Concept Design Workshop held on June 19, 2018, that this area was evaluated during the Turkey Creek project completed by the US Army Corps of Engineers (USACE). The cost benefit ratio for this project was not comparable because of the lack of structures and therefore the USACE assigned responsibility to the local sponsor, the UG. A concept was developed for an interceptor that would reduce flows to this site. This proposed interceptor concept should be evaluated at the preliminary design phase.

Figure E-55. TURK-4 Project Location.

Existing Condition

Roadway flooding has been documented at the Southwest Boulevard and Mission Road interchange, extending south along Mission Road to 40th Terrace, at the TURK-4 site. As shown in the figure belowFigure , there is a concentration of stormwater inlets that collect flow and convey west to Turkey Creek.

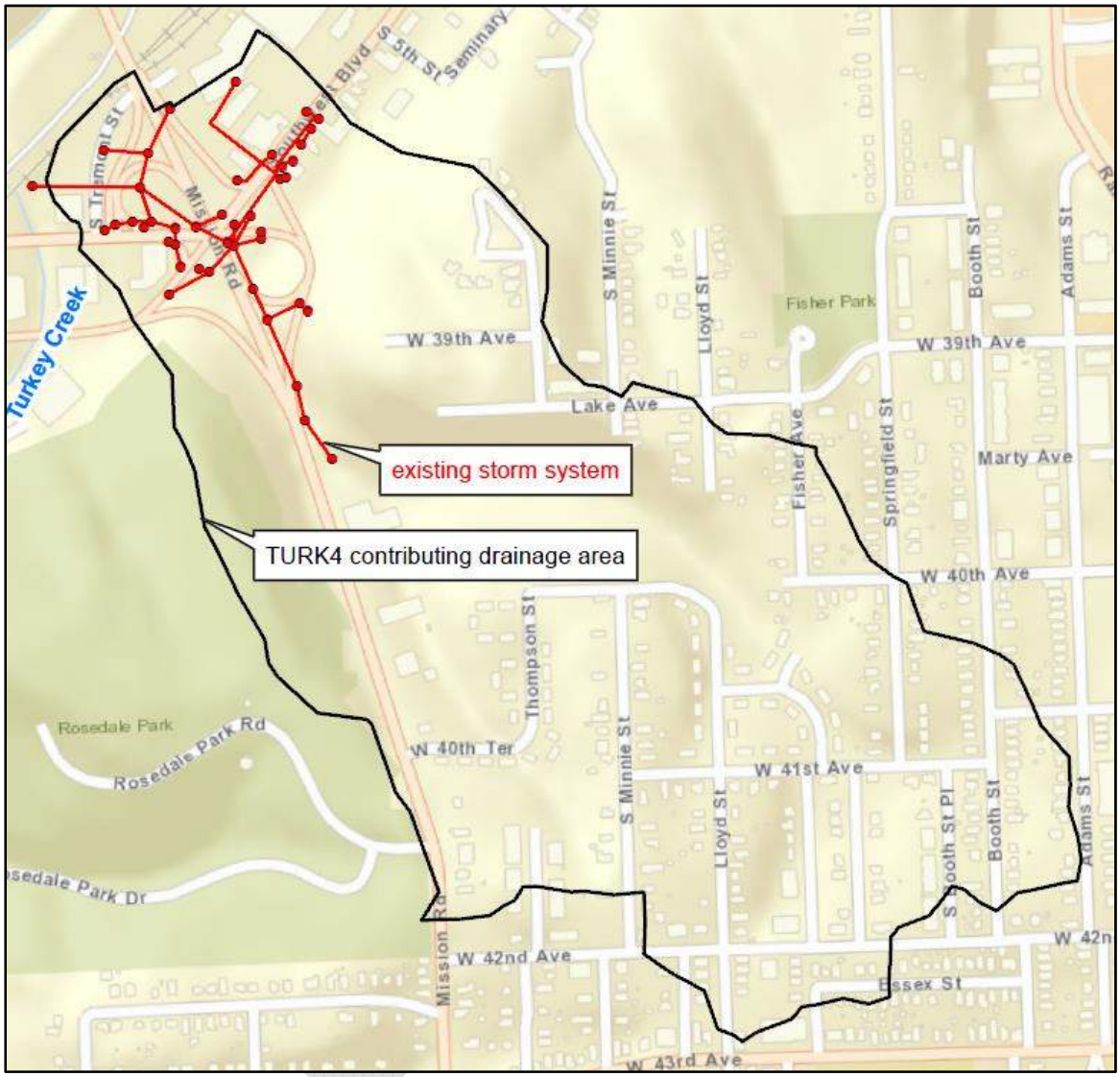

Figure E-56. TURK-4 Existing Stormwater Network.

Draft modeling confirmed that the most significant flooding occurs near the exit ramp onto I-35 North. The surface grate 051-533-IT is the central node of flooding, with flood losses at upstream inlets 050-560-IT, 050-561-IT, 051-534-IT, and 051-535-IT. The surface topography at this location is a low lying, depression relative to the surrounding area. Figure E-57 highlights the location of structure 051-533-IT.

Structure 051-533-IT also receives upstream flow from five piped conveyance lines. Most notably, the southern pipe conveys stormwater from a combined drainage area of roughly 100 acres. Directly

downstream of 051-533-IT is structure 051-577-IT which receives piped conveyance from an eastern network along Southwest Boulevard.

Survey data of the stormwater network confirmed inadequate drainage at structures 051-533-IT and 051-577-IT. While surveying during dry conditions, surveyors noted over 1 foot of standing water in the manholes.

Figure E-57. TURK-4 Location of Most Significant Flooding, Structure 051-533-IT.

Other network issues at this location along the ramp include the failure of inlet 051-535-IT. Survey indicated that the inlet has been completely filled as shown in Figure 8.

Figure E-58. Survey Photo of Inlet 051-535-IT with No Inlet Capacity.

Beyond the main flooding at structure 051-533-IT, draft modeling indicated additional flood losses of the stormwater network at various locations throughout TURK-4. Such losses were identified and addressed when evaluating a proposed solution for the 5-year storm event.

Proposed Solution

In order to adequately convey the 5-year storm event to the existing TURK-4 outfall, the main conveyance line will need to be substantially upsized. Based on initial modeling, it is proposed that the main line be increased from a pipe of maximum 66" diameter to a reinforced concrete box with a maximum size of 9' x 6'. Figure E-59 provides a schematic of the proposed main lines to be replaced.

Figure E-60 indicates the remaining sections of the TURK-4 network that cannot adequately convey the 5-year storm event. Proposed sizes are noted on the schematics. All proposed material type is reinforced concrete.

Of note, another smaller outfall to Turkey Creek is located along Southwest Boulevard within the immediate vicinity of the TURK-4 site though the capacity of this outfall is unknown at this time. Given the known vulnerabilities at structure 051-533-IT, another solution that may be proposed is the disconnection and re-routing of upstream flow from this structure and upsizing the secondary outfall. This aligns with the aforementioned interceptor concept and should be evaluated in preliminary engineering.

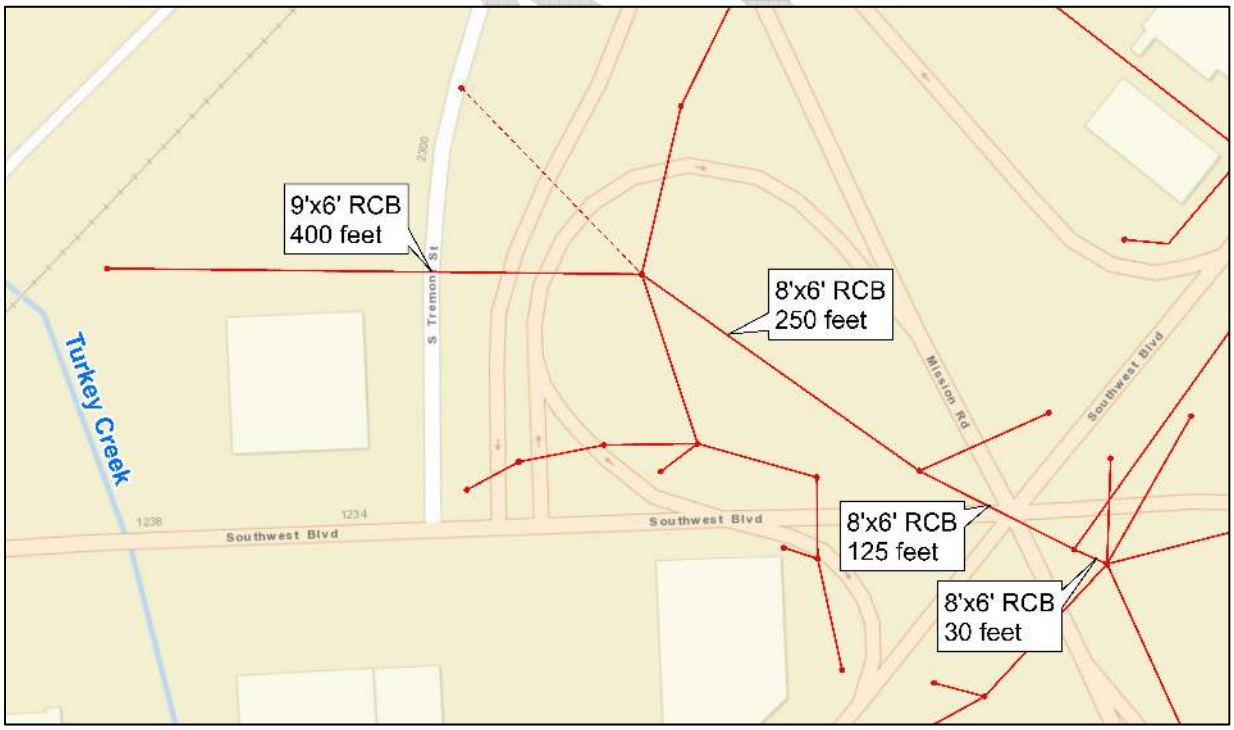

Figure E-59. TURK-4 Proposed Stormwater Network Upsizing of Main Conveyance for 5-Year Storm Event.

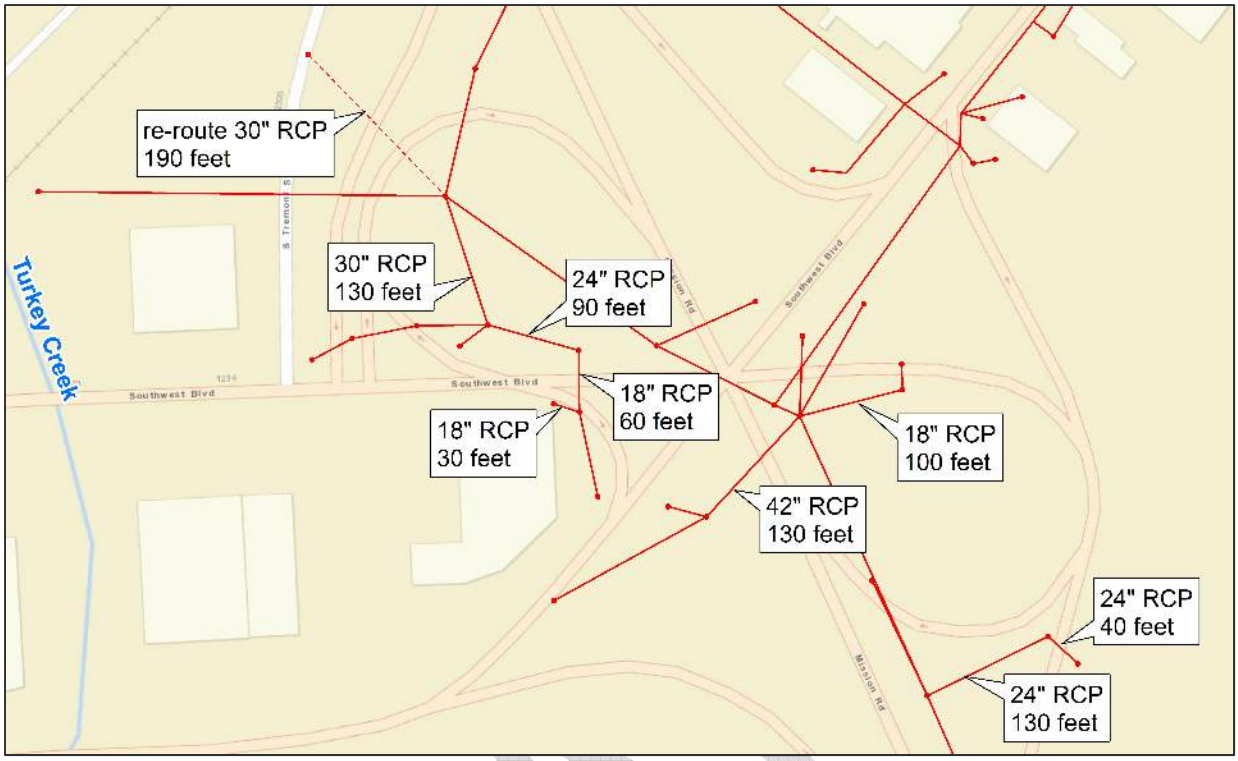

Figure E-60. TURK-4 Proposed Stormwater Network Upsizing of Smaller Conveyance for 5-Year Storm Event.

APPENDIX F - CONCEPTUAL OPINION OF PROBABLE COST

The Opinion of Probable Construction Cost estimates (hereinafter "OPCC" or "Estimate") are based on a level of design detail and information that is directly related to the stage of design and the level of effort budgeted to produce said estimate. As such, these estimates are preliminary with a range of uncertainty. Each OPCC estimate is prepared for guidance in project evaluation and implementation from the information available at the time the estimate was developed. The final costs of the project will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions such as market events beyond the control of B&V, and political events. As a result, the OPCC does not represent a certainty, and the final project costs may vary from the OPCC cost.

SUMMARY OF COSTS

The estimate includes anticipated construction costs including escalation to midpoint of construction, construction contingency, permitting fees, and applicable taxes. Budget costs were developed using historical costs from past projects, estimating team experience in the industry, material cost from historical quotes as well as numerous other sources. Based on the aggregate of this information, the OPCC was developed.

ESTIMATE ACCURACY

The estimate is based on the Draft UG Stormwater Master Plan dated 1 July 2018 and a bill of quantities developed for respective projects. This estimate has been prepared for guidance in project evaluation and implementation from the information available at the time the estimate was developed. The final costs of the project will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the estimate presented herein.

UNIT PRICE RESOURCES

The following industry resources were used in developing this cost estimate:

- Black & Veatch Historical Data
- RSMeans Construction Cost Data
- Mechanical Contractors Association - Labor Manual
- National Electrical Contractors Association - Labor Unit Manual (NECA)
- Vendor Quotes on Equipment and Materials where available
- Vendor/Distributor in-stock pricing for common construction items

Labor unit prices reflect a burdened rate, including: workers compensation, unemployment taxes, fringe benefits, medical insurance and other applicable markups based on project location, adjusted from the RSMeans national average using area adjustment factors presented in the current annual labor index in RSMeans.

ESTIMATE EXCLUSIONS

- Land acquisition costs or fees other than the parcels 009959 and 009800 specified in the estimate
- Permitting costs or fees, other than specified
- Subsurface utility engineering or planning
- Utility relocation other that what is shown on the bill of quantity.
- Removal, transportation, handling, classification, disposal or replacement of hazardous or deleterious soils or other materials, including groundwater.
- Removal, transportation, handling, classification, disposal or replacement of rock or rock-like materials other that what is specified on the estimate.
- Existing material salvage values and the resulting impact on total project cost.
- No crossing of elevated roadway is included in the estimate. All utility and piping work is assumed as open cut with adequate clearance.
- Sales tax is excluded.

ESTIMATE ASSUMPTIONS

Due to the current level of design and available resources to complete this estimate, the following assumptions were applied:

- A 5-day per week, 8-hour shift was assumed during construction. Work shifts and restrictions per project requirements will not require off-hour and extended work periods.
- Utility relocations may be possible however until actual field surveys are performed and design is completed types and quantities cannot be determined. For estimating purposes, an allowance of 5% of direct construction costs has been included.
- Excess earthwork spoils are assumed to be transported to landfill locations no more than 5 miles from construction locations. No dump fees have been included.
- Traffic control is included as an allowance. It is assumed that temporary road closures and detours may be utilized as necessary to limit cost impacts on construction costs.
- Only casual/occasional dewatering is included. No known geological information is available to indicate work will take place below groundwater tables requiring specific dewatering activities.
- Surveying services included as an allowance.

GENERAL PRICING NOTES

Construction Labor

Wage rates were estimated based on Kansas City Wyandotte County Prevailing wages. Productivities were evaluated based on actual jobsite conditions and adjusted accordingly to match the difficulties of items such as access to work, conditions of surrounding environment, quality and access to qualified craft, as well as weather conditions that can and will affect the overall performance of said craft. An all-in wage rate was used for the estimate. The stated wage rate includes base raw labor rate, fringes,

insurance, overhead, and labor burden. Loaded wage rates are based on 8-hour days without adjustment for overtime. If overtime is required due to scheduling constraints, adjustments to the wage rate for overtime pay as well and productivity adjustments should be taken into account.

Construction Equipment

Construction equipment is based on Rental Blue book rates based on the monthly rate published on a national average, updated annually.

Materials

Prices are based on a combination of Black & Veatch historical material estimating data base, recent vendor quote/pricing information and project specific quotes for various sizes of RCP and HDPE piping (Advanced Drainage Systems, Inc).

Construction General Conditions

Construction management is included as a percentage.

- Construction Management 8%
- Travel & Subsistence 2%
- Temporary Facilities 1%
- GC Equipment 0.5%
- Start-up 1.5%
- Permits 0.5%

Escalation

Escalation has been estimated based on 5 years @ 3%/year, compounded annually. 21.67% escalation is used for this project.

Construction Contingency

An estimate construction contingency of 35% has been included in the estimate. Contingency is applied as a function of the level of design definition as well as level of effort applies to said estimate.

Division Pricing Notes

Division 01 - General Conditions & Indirects

1. All estimating costs are for the Owner's account unless otherwise agreed and stated within the estimate documents.
2. No overtime charges are included for field labor, supervision, support staff or design staff.
3. Weather delays in construction schedule are anticipated to be in accordance with averages published by NOAA for said location.
4. Union agreements are not required as part of the terms of the contract with the Constructor
5. Unless stated as a sole source supplier, all specifications are assumed to contain an "or equal" clause.
6. No expediting costs are included to meet the schedule unless otherwise stated in the estimate documents.

7. All field management staff is assumed to be located outside of said location thus requiring travel and subsistence for field management staff.
8. Temporary water is provided by the owner and only required a temp service connection for construction water as well as potable water for service of the construction trailers.
9. Landscape restoration is included as an allowance.
10. Sales tax is excluded.
11. Surveying services included as an allowance.
12. Demolition of existing storm water piping and infrastructure included as far as what is encountered within the new excavations only.
13. Project wage rates are based on Kansas City Kansas and Wyandotte County prevailing wage determination.

Division 02 – Sitework

1. Subsurface investigations have not been completed so, estimating team used profile drawings to come up with quantities and following assumptions are made for geotechnical;
    a. Average depth for cover over piping and culverts used – 4’ for pipes less than 72” dia.
    b. Average depth for cover over piping and culverts used – 6’ for pipes more than 72” dia.
    c. No rock excavation included, soils to be excavated with conventional equipment and spoils to be suitable for backfill
    d. 12” aggregate bedding provided under all piping and culverts
    e. No known geological information is available to indicate work will take place below groundwater tables requiring specific dewatering activities. So, no flowable fill is used to CL of pipe.
    f. 1' of bedding material below pipe
    g. No vertical bench in excavation
    h. 1:1 side slopes above trench box
    i. Bottom of excavation to extend 2' beyond OD of pipe
2. Pavement removal/replacement based on width of excavations and assumed to be present over all new piping and culverts.
3. Asphalt paving assumed to be 4” base course w/ 2” top course over 6” aggregate base
4. RCP assumed to be Class 3, no gaskets
5. No crossing of elevated roadway such as jacking and boring or micro-tunneling is included in the estimate. All utility and piping work is assumed as conventional open cut with adequate access and clearance.
6. No subsurface rock exists on the open trench piping.
7. Excessive dewatering is not anticipated in these sites nor included in the estimate. Only casual/occasional dewatering is included. Excavated material is assumed not suitable.
8. Demolition of existing storm water piping and infrastructure included as far as what is encountered within the new excavations only.
9. No hazardous material exists in, or is a part of, existing construction, surface or subsurface material.

10. All subsurface obstacles or interferences have not been disclosed or included in the estimate.
11. There will be significant amount of road/lane closures during construction and this has been taken into consideration in our estimate. Traffic control is included as an allowance. It is assumed that temporary road closures and detours may be utilized as necessary to limit cost impacts on construction costs.
12. Estimate assumes no pipe or other existing utility interferences other than what is included in the estimate. Estimate also includes hydro-excavating cost to locate underground utilities.
13. No rerouting of existing utilities that may be in conflict with proposed improvements is included

Detailed summaries of the cost estimate for each recommended project are included in this appendix.

ARGE-1 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	127	EA	$ 807,766
Demolition	4405	LF	$ 242,275
Landscape Restoration Allowance	4405	LF	$ 66,075
Precast Manhole (6- Diameter)	5	EA	$ 41,660
Paving Removal/Replacement	2680	SY	$ 321,650
15" RCP (with Excavation and B/F)	4070	LF	$ 759,463
27" RCP (with Excavation and B/F)	15	LF	$ 3,712
30" RCP (with Excavation and B/F)	55	LF	$ 15,906
36" RCP (with Excavation and B/F)	115	LF	$ 34,505
72" RCP (with Excavation and B/F)	150	LF	$ 74,280
Surveying Allowance	71	HOUR	$ 9,585
Traffic Control Allowance	1	LS	$ 110,125
Utility Relocation Allowance	1	LS	$ 15,548
Sub-Total (Total Direct Cost)			**$ 2,502,550**
Allowances (7%)			$ 175,179
Total Direct Cost with Allowances			$ 2,677,729
Construction Contingency (35%)			$ 937,205
Escalation – 5 years at 4%/year			$ 580,264
Total Including Risk			$ 4,195,197
General Requirements (13.5%)			$ 566,352
Total Including General Req			$ 4,761,549
Contractor Fee (14.4%)			$ 685,663
Total Including Fee			$ 5,447,212
Insurances & Bond (2.29%)			$ 124,741
Engineering (10%)			$ 544,721
Total Construction Cost			**$ 6,116,700**

ARMO-3 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
18" RCP	142	LF	$ 18,288
24" RCP	31	LF	$ 7,539
27" RCP	60	LF	$ 10,895
30" RCP	40	LF	$ 9,279
39" RCP	303	LF	$ 84,255
42" RCP	307	LF	$ 87,986
45" RCP	162	LF	$ 47,536
48" RCP	415	LF	$ 125,430
51" RCP	105	LF	$ 30,518
54" RCP	460	LF	$ 150,369
2' x 3' RCB	345	LF	$ 169,316
2' x 4' RCB	2130	LF	$ 1,069,984
3' x 5' RCB	540	LF	$ 327,866
3' x 6' RCB	1120	LF	$ 709,251
5' x 5' RCB	955	LF	$ 740,049
6' x 6' RCB	1055	LF	$ 874,141
7' x 8' RCB	800	LF	$ 790,432
Manhole, 6' Diameter	18	EA	$ 146,335
Area Inlet - 10' x 3'	30	EA	$ 164,159
Asphalt paving	19933	SY	$ 1,213,920
Sidewalk	2000	SY	$ 32,500
Area Restoration	37400	SY	$ 46,750
Traffic Control Allowance	1	LS	$ 67560
Sub-Total (Total Direct Cost)			**$ 6,924,358**
Allowances			$ 627,477
Total Direct Cost with Allowances			$ 7,551,835
Construction Contingency			$ 2,643,142
Escalation – 5 years at 4%/year			$ 1,636,483
Total Including Risk			$ 11,831,459

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
General Requirements			$ 1,302,818
Total Including General Req.			$ 13,134,277
Contractor Fee			$ 1,460,042
Total Including Fee			$ 14,594,319
Insurances & Bond			$ 188,619
Engineering			$ 1,459,432
Total Construction Cost			**$16,242,400**

ARMO-5 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
RCB Headwalls (with Excavation and B/F)	1	LS	$ 14,768
Concrete Curb Inlets (with Excavation and B/F)	170	EA	$ 1,081,262
Demolition	6,531	LF	$ 718,410
Landscape Restoration Allowance	6,531	LF	$ 97,965
Precast Manhole (6'-Diameter)	40	EA	$ 333,283
Paving Removal and Replacement	10,025	SY	$ 1,203,000
8' x 9' RCB Culvert	182	LF	$ 138,582
84" RCP	1110	LF	$ 4,548,536
108" RCP	485	LF	$ 405,489
120" RCP	3,873	LF	$ 1,394,208
132" RCP	3,249	LF	$ 4,008,336
Surveying Allowance	131	HOUR	$ 17,685
Traffic Control Allowance	1	LS	$ 163,275
Sub-Total (Total Direct Cost)			**$ 14,870,595**
Allowances (7%)			$ 1,040,942
Total Direct Cost with Allowances			$ 15,911,537
Construction Contingency (35%)			$ 5,569,038
Escalation – 5 years at 4%/year			$ 3,447,281
Total Including Risk			$ 24,927,855
General Requirements (13.5%)			$ 3,365,260
Total Including General Req			$ 28,293,115
Contractor Fee (14.4%)			$ 4,074,209
Total Including Fee			$ 32,367,324
Insurances & Bond (2.29%)			$ 741,212
Engineering (10%)			$ 3,236,732
Total Construction Cost			**$ 36,345,300**

JERS-1 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	5	EA	$31,802
Demolition	1,485	EA	$ 163,350
2’ x 4’ RCB	195	LF	$97,956
3’ x 4’ RCB	45	LF	$24,482
Landscape Restoration Allowance	1,485	EA	$22,275
Precast Manhole (6'-Diameter	6	SY	$49,992
Paving Removal and Replacement	1,112	LF	$133,440
15” RCP	217	LF	$ 54,443
18" RCP	200	LF	$ 39,053
27” RCP	220	LF	$ 40,492
30" RCP	285	LF	$79,327
33" RCP	760	LF	$222,108
Surveying Allowance	24	HOUR	$3,240
Traffic Control Allowance	1	LS	$37,125
Utility Relocation Allowance	1	LS	$15,548
Sub-Total (Total Direct Cost)			**$1,014,633**
Allowances (7%)			$71,024
Total Direct Cost with Allowances			$1,085,657
Construction Contingency (35%)			$379,980
Escalation – 5 years at 4%/year			$235,211
Total Including Risk			$1,700,848
General Requirements (13.5%)			$229,615
Total Including General Req			$1,930,463
Contractor Fee (14.4%)			$277,987
Total Including Fee			$2,208,449
Insurances & Bond (2.29%)			$50,573
Engineering (10%)			$220,845
Total Construction Cost			$2,479,900

JERS-2 Opinion of Probable Cost

ITEM DESCRIPTION	AMOUNT	UNIT	OPCC	
15" RCP	320	LF	$	20,278
27" RCP	420	LF	$	81,682
33" RCP	120	LF	$	36,756
2' x 4' RCB	80	LF	$	40,712
3' x 4' RCB	265	LF	$	144,171
3' x 5' RCB	20	LF	$	15,179
3' x 6' RCB	75	LF	$	48,548
4' x 4' RCB	25	LF	$	18,884
4' x 5' RCB	660	LF	$	444,385
4' x 6' RCB	180	LF	$	125,935
4' x 7' RCB	180	LF	$	131,495
5' x 8' RCB	310	LF	$	242,581
6' x 6' RCB	345	LF	$	286,895
6' x 9' RCB	287	LF	$	257,155
7' x 9' RCB	760	LF	$	645,308
8' x 9' RCB	360	LF	$	383,443
9' x 9' RCB	1360	LF	$	1,750,062
9' x 10' RCB	1690	LF	$	2,120,342
10' x 10' RCB	1710	LF	$	2,315,768
10' x 11' RCB	645	LF	$	967,294
Manhole, 6' Diameter	5	EA	$	40,649
Area Inlet - 10' x 3'	150	EA	$	1,115,960
Asphalt Removal/Patching	22404	SY	$	1,362,611
Asphalt Marking	1000	SY	$	3,500
Sidewalk Removal/Replacement	2000	SY	$	32,500
Restoration of Area	42008	SY	$	52,510
Traffic Allowance	2	MO	$	67,560
Sub-Total (Total Direct Cost)			**$**	**12,752,162**
Allowances			$	683,148
Total Direct Cost with Allowances			$	13,435,310
Construction Contingency			$	4,815,850
Escalation – 5 years at 4%/year			$	2,911,432
Total Including Risk			$	21,162,591
General Requirements			$	3,267,130
Total Including General Req			$	23,539,051
Contractor Fee			$	2,841,353

ITEM DESCRIPTION	AMOUNT	UNIT	OPCC
Total Including Fee			$ 26,380,404
Insurances & Bond			$ 367,067
Engineering			$ 2,638,040
Total Construction Cost			**$ 29,385,500**

JERS-3 Opinion of Probable Cost

ITEM DESCRIPTION	AMOUNT	UNIT	OPCC
Existing Concrete Channel Demolition	3778	CY	$ 116,287
Channel Excavation, Backfill, & Reshaping	594000	CY	$ 12,830,400
Pavement Removal	5200	SF	$ 10,608
Filter Course for Riprap	2444	CY	$ 112,204
Riprap in Channel	19556	CY	$ 834,846
Topsoil Import	7407	CY	$ 320,427
Traffic Control	2	MO	$ 67,560
10' x 10' RCB	80	LF	$ 112,642
New Headwalls and Apron	20	EA	$ 250,000
New Road Base	580	SY	$ 8,723
Asphalt Paving	580	SY	$ 12,180
Guard Rail	340	LF	$ 17,000
Pedestrian Steel Bridge Allowance	3	EA	$ 170,484
Restoration Area	43560	SY	$ 31,363
Trees	40	EA	$ 11,920
Sub-Total (Total Direct Cost)			$ **14,906,643**
Allowances			$ 327,250
Total Direct Cost with Allowances			$ 15,233,893
Construction Contingency			$ 5,382,432
Escalation – 5 years at 4%/year			$ 3,301,185
Total Including Risk			$ 23,917,510
General Requirements			$ 2,554,349
Total Including General Req			$ 26,471,859
Contractor Fee			$ 2,857,953
Total Including Fee			$ 29,329,812
Insurances & Bond			$ 367,067
Engineering			$ 2,932,981
Total Construction Cost			**$32,629,900**

LTTN-2 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Excavation	5	CY	$112,590
Property Acquisition	1,485	LS	$155,970
Concrete Riser Outlet Structure	195	EA	$30,864
Riprap	45	CY	$5,123
Surveying Allowance	24	HR	$3,240
Utility Relocation Allowance	1	LS	$7,750
Existing Concrete Channel Demolition	1438	CY	$44,255
Channel Excavation, Backfill, & Reshaping	1498	CY	$32,350
Riprap in Channel	1528	CY	$65,215
Sub-Total (Total Direct Cost)			**$457,357**
Allowances (7%)			$32,015
Total Direct Cost with Allowances			$489,372
Construction Contingency (35%)			$171,280
Escalation – 5 years at 4%/year			$106,047
Total Including Risk			$798,714
General Requirements (13.5%)			$107,826
Total Including General Req			$906,540
Contractor Fee (14.4%)			$130,542
Total Including Fee			$1,037,082
Insurances & Bond (2.29%)			$23,749
Engineering (10%)			$103,708
Total Construction Cost			**$1,164,600**

MILL-3 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	12	EA	$ 114,292
Demolition	1485	LF	$ 163,350
18" HDPE	235	LF	$ 23,622
36" HDPE	165	LF	$ 25,503
42" HDPE	544	LF	$ 94,179
48" HDPE	318	LF	$ 40,606
54" HDPE	598	LF	$ 140,336
Landscape Restoration Allowance	2178	LF	$ 32,670
Precast Manhole (6'-Diameter)	5	EA	$ 41,660
Paving Removal and Replacement	1931	SY	$ 231,720
4' x 5' RCB Culvert	300	LF	$ 201,993
4' x 7' RCB Culvert	280	LF	$ 204,548
RCB Headwalls	74	CY	$ 35,146
Surveying Allowance	40	HOUR	$ 5,400
Traffic Control Allowance	1	LS	$ 54,450
Utility Relocation Allowance	1	LS	$ 27,123
Sub-Total (Total Direct Cost)			**$ 1,436,598**
Allowances (7%)			$ 100,561
Total Direct Cost with Allowances			$ 1,537,159
Construction Contingency (35%)			$ 538,005
Escalation – 5 years at 4%/year			$ 333,102
Total Including Risk			$ 2,408,268
General Requirements (13.5%)			$ 325,116
Total Including General Req			$ 2,733,384
Contractor Fee (14.4%)			$ 393,607
Total Including Fee			$ 3,126,991
Insurances & Bond (2.29%)			$ 71,608
Engineering (10%)			$ 312,699
Total Construction Cost			**$ 3,511,300**

MILL-5 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	5	EA	$47,622
Demolition	1,093	LF	$120,230
21" HDPE	31	LF	$3,948
24" HDPE	389	LF	$20,461
60" HDPE	354	LF	$85,765
Landscape Restoration Allowance	1,093	LF	$16,395
Precast Manhole (6'-Diameter)	5	EA	$41,660
Paving Removal and Replacement	837	SY	$100,440
21" RCP	319	LF	$67,923
Surveying Allowance	24	HOUR	$3,240
Traffic Control Allowance	1	LS	$27,325
Utility Relocation Allowance	1	LS	$12,439
Sub-Total (Total Direct Cost)			**$547,448**
Allowances (7%)			$38,321
Total Direct Cost with Allowances			$585,769
Construction Contingency (35%)			$205,019
Escalation – 5 years at 4%/year			$126,936
Total Including Risk			$917,725
General Requirements (13.5%)			$123,893
Total Including General Req			$1,041,618
Contractor Fee (14.4%)			$149,993
Total Including Fee			$1,191,611
Insurances & Bond (2.29%)			$27,288
Engineering (10%)			$119,161
Total Construction Cost			**$1,338,100**

MILL-6 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	4	EA	$25,441
Demolition	870	LF	$95,700
24" HDPE	680	LF	$82,119
33" HDPE	110	LF	$16,510
Landscape Restoration Allowance	870	LF	$13,050
Precast Manhole (6'-Diameter)	5	EA	$41,660
Paving Removal and Replacement	588	SY	$70,560
21" RCP	40	LF	$8,497
24" RCP	40	LF	$9,026
Surveying Allowance	24	HOUR	$3,240
Traffic Control Allowance	1	LS	$21,750
Utility Relocation Allowance	1	LS	$12,439
Sub-Total (Total Direct Cost)			**$399,992**
Allowances (7%)			$27,999
Total Direct Cost with Allowances			$427,991
Construction Contingency (35%)			$149,797
Escalation – 5 years at 4%/year			$92,746
Total Including Risk			$670,534
General Requirements (13.5%)			$90,522
Total Including General Req			$761,056
Contractor Fee (14.4%)			$109,592
Total Including Fee			$870,648
Insurances & Bond (2.29%)			$19,938
Engineering (10%)			$87,065
Total Construction Cost			**$977,700**

MUNC-1 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	4	EA	$22,841
Demolition	2,130	LF	$234,300
Landscape Restoration Allowance	2,130	LF	$31,950
Precast Manhole (6'-Diameter)	3	EA	$24,996
Paving Removal and Replacement	2,021	SY	$242,520
48" RCP	985	LF	$370,738
60" RCP	985	LF	$490,180
60" RCP Flared End Section	1	EA	$7,682
Surveying Allowance	48	HOUR	$6,480
Traffic Control Allowance	1	LS	$53,250
Utility Relocation Allowance	1	LS	$23,249
Sub-Total (Total Direct Cost)			**$1,508,186**
Allowances (7%)			$105,573
Total Direct Cost with Allowances			$1,613,759
Construction Contingency (35%)			$564,816
Escalation – 5 years at 4%/year			$349,702
Total Including Risk			$2,528,276
General Requirements (13.5%)			$341,317
Total Including General Req			$2,869,594
Contractor Fee (14.4%)			$413,221
Total Including Fee			$3,282,815
Insurances & Bond (2.29%)			$75,176
Engineering (10%)			$328,282
Total Construction Cost			**$3,686,300**

TURK-4 Opinion of Probable Cost

ITEM DESCRIPTION	QUANTITY	UNIT	OPCC
Concrete Curb Inlets (with Excavation and B/F)	2	EA	$42,062
Demolition	1,705	LF	$187,550
Landscape Restoration Allowance	1,705	LF	$25,575
Paving Removal and Replacement	1,810	SY	$217,200
8' x 6' RCB Culvert	405	LF	$315,337
9' x 6' RCB Culvert	400	LF	$361,273
RCB Headwalls	72	CY	$34,024
18" RCP	190	LF	$37,254
24" RCP	260	LF	$49,511
30" RCP	320	LF	$82,460
42" RCP	130	LF	$48,583
Surveying Allowance	32	HOUR	$8,100
Traffic Control Allowance	1	LS	$43,250
Utility Relocation Allowance	1	LS	$23,249
Sub-Total (Total Direct Cost)			**$1,475,428**
Allowances (7%)			$103,280
Total Direct Cost with Allowances			$1,578,708
Construction Contingency (35%)			$552,548
Escalation – 5 years at 4%/year			$342,106
Total Including Risk			$2,473,362
General Requirements (13.5%)			$333,904
Total Including General Req			$2,807,266
Contractor Fee (14.4%)			$404,246
Total Including Fee			$3,211,512
Insurances & Bond (2.29%)			$73,544
Engineering (10%)			$321,151
Total Construction Cost			**$3,606,300**